RECEIVED
DEC 28 1956
GATES CO.

One of the
DU MONT
400
Series

404 + 404-R

# TYPE 404 & 404-R PULSE GENERATORS

## OPERATION • MAINTENANCE

DU MONT

# PULSE GENERATORS

## TYPES 404 and 404-R

**Allen B. Du Mont Laboratories, Inc.**
TECHNICAL PRODUCTS DIVISION

760 BLOOMFIELD AVENUE, CLIFTON, N. J., U. S. A.

Copyright 1956
ALLEN B. DU MONT LABORATORIES, INC.
TECHNICAL PRODUCTS DIVISION
Clifton, N. J.
U. S. A.

Part Number 67028191

PRINTED IN U.S.A.

Printing Produced by
THE GEORGE R. EPPLE CO.
Somerville, N. J.

# TABLE OF CONTENTS


## Section 1 Technical Summary

Paragraph — Page

1-1. Introduction ..... 1
1-2. Purpose ..... 1
1-3. Features ..... 1

## Section 2 Operation

2-1. General ..... 3
2-2. Energizing the Equipment ..... 3
2-3. Operating Hints ..... 3
2-4. Front Panel Facilities ..... 5

## Section 3 Theory of Operation

3-1. General ..... 6
3-2. Synchronizer ..... 6
3-3. Timing and Pulse Generator ..... 6
3-4. Pulse Driver and Output ..... 8
3-5. Attenuator ..... 11
3-6. Power Supply ..... 11

## Section 4 Maintenance

4-1. General ..... 12
4-2. Service Adjustments ..... 12
4-3. Servicing Hints ..... 12

## Section 5 Electrical Parts List and Schematics

Electrical Parts List ..... 27


## LIST OF TABLES


Table — Page

1-1. Technical Summary Du Mont Types 404 and 404-R Pulse Generators ..... 1
2-1. Front-Panel Facilities ..... 4
4-1. Test Equipment Required for Service Adjustments ..... 12
4-2. Service Adjustment Chart ..... 17
4-3. Adjustments to be Made When Replacing Tubes ..... 20
4-4. Symptoms of Tube Failure Chart ..... 21
4-5. Voltage Measurements ..... 23
4-6. Resistance Measurements ..... 25


## ILLUSTRATIONS


Figure — Page

1-1. Type 404 Pulse Generator ..... Frontispiece
2-1. Method for Viewing Pulses Direct at Cathode-Ray Tube Plates ..... 3
3-1. Over-all Functional Block Diagram, Type 404/404-R Pulse Generator ..... 6
3-2. Type 404/404-R Pulse Generator Simplified Timing Diagram ..... 9
3-3. Distributed Cathode Followers, Simplified Schematic ..... 10
4-1. Tubes and Adjustments, Rear View ..... 13
4-2. Tubes and Adjustments, Bottom View ..... 14
4-3. Tubes and Adjustments, Top View ..... 15
4-4. Tubes and Adjustments, Right Side ..... 16
5-1. Schematic, Synchronizer (98001381-4, Sheet 1 of 5, issue 2) ..... 31
5-2. Schematic, Timing and Pulse Generator (98001381-4, Sheet 2 of 5, issue 1) ..... 33
5-3. Schematic, Pulse Driver and Output (98001381-4, Sheet 3 of 5, issue 1) ..... 35
5-4. Schematic, Attenuator (98001381-4, Sheet 4 of 5, issue 1) ..... 37
5-5. Schematic, Power Supply and Heater Circuits (98001381-4, Sheet 5 of 5, issue 2) ..... 39

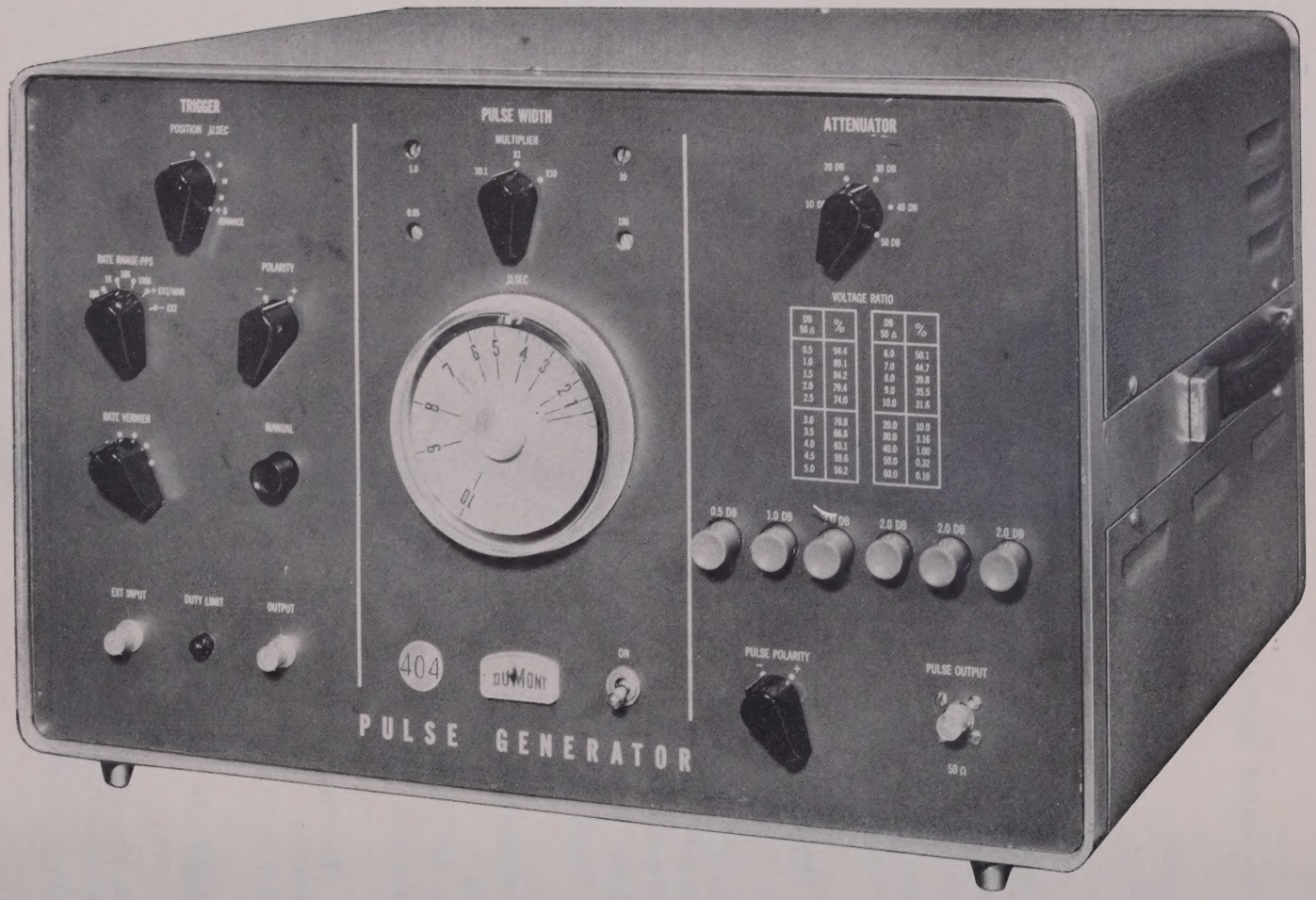



***Figure 1-1. Du Mont Type 404 Pulse Generator***

# SECTION 1
# TECHNICAL SUMMARY

### 1-1. INTRODUCTION

This manual of operating and maintenance instructions contains information on both the Type 404 (bench model) and Type 404-R (rack mounted) Pulse Generators. Electrically, the two types are identical; mechanically, they differ in exterior appearance. These differences are clearly indicated in the text. Otherwise, references throughout the manual to the Type 404 pertain also to the Type 404-R.

### 1-2. PURPOSE

The Type 404 is a general purpose Pulse Generator providing good-quality pulses of useful level for test purposes. This instrument generates pulses ranging in width from 0.05 microsecond to 100 microseconds and with repetition rates up to 100K pulses per second at combinations of pulse width and repetition rate up to 10% duty cycle.

### 1-3. FEATURES

- Good-quality pulses variable in width from 0.05 to 100 microseconds.
- Repetition rates from single pulse operation (MANUAL) and continuously variable from 10 to 100K pulses per second (internal or external initiation).
- Positive overload protection eliminates danger of damaging the instrument, regardless of control setting.
- Jitter-free OUTPUT trigger available to initiate external equipment before or after pulse start.
- Precision ladder attenuator, controls pulse amplitude in 0.5 db increments, from 0 attenuation to 59.5 db down.

## TABLE 1-1
## TECHNICAL SUMMARY
## DU MONT TYPES 404 AND 404-R PULSE GENERATORS

| | |
|---|---|
| **1. PULSE OUTPUT** | |
| a. Amplitude | |
| (1) Peak voltage | 50 volts, ±10% (with termination) |
| (2) Overshoot and ring | Not more than 3% |
| (3) Attenuation | ATTENUATOR enables reduction of pulse amplitude in 0.5 db increments to 59.5 db |
| (4) Incremental accuracy | ±3% each step of the ATTENUATOR |
| b. Polarity | Switched positive or negative |
| c. Output Impedance | 50 ohms |
| d. Duration | |
| (1) Width | 0.05 μsec to 100 μsec, continuously variable; minimum width can be calibrated at front panel |
| (2) Rise or fall time | 18 milli-μsec maximum |
| (3) Duty cycle | 10% maximum with prevention of operation beyond specified duty cycle |

## TABLE 1-1. TECHNICAL SUMMARY (Continued)

e. Repetition Rate

| | |
|---|---|
| (1) Internal | 10 pps to 100 pps, ±10%, uncalibrated |
| (2) External | Can be triggered by pulses having the following characteristics:<br>Amplitude: from 2 to 100 volts peak<br>Polarity: positive or negative<br>Rise time: 1 μsec or less<br>Rep rate: single transients to greater than 100 pps |
| (3) Manual | Push button provides single pulse of selected width and amplitude |

**2. TRIGGER OUTPUT**

| | |
|---|---|
| a. Amplitude | 25 volts, ±20% when properly terminated |
| b. Duration | |
| (1) Width | 0.1 μsec |
| (2) Rise time | 0.05 μsec |
| c. Output Impedance | 50 ohms |
| d. Polarity | Switched positive or negative |
| e. Jitter With Respect to PULSE OUTPUT | 2 milli-μsec maximum |
| f. Delay With Respect to an External Trigger | Fixed, 5 μsec, ±10% |

**3. PULSE POSITION**

| | |
|---|---|
| a. Internal, External, or Manual Operation | PULSE OUTPUT start can be advanced up to 2 μsec or delayed up to 8 μsec with respect to the delayed trigger OUTPUT |
| b. Delay of PULSE OUTPUT With Respect to an External Trigger | 3 μsec minimum to 13 μsec maximum (measured with respect to the 10% point on the leading edge of an external trigger) |
| c. *Pulse Delay Duty Cycle | 80%; e.g., at a rep rate of 100,000 pps, PULSE OUTPUT start can be delayed up to 4 μsec maximum, with respect to the delayed trigger OUTPUT; up to 9 μsec maximum, with respect to an external trigger or to the undelayed internal trigger |

* Pulse delay interval is defined as the time between the internal or external trigger and the start of the output pulse

**4. POWER REQUIREMENTS**

| | |
|---|---|
| a. Primary Source | 115 volts, ±10% (230-volt unit available upon request) |
| b. Primary Frequency | 50-60 cycles |
| c. Power Consumption | 600 VA |

**5. SIZE AND WEIGHT**

| | Type 404 | Type 404-R |
|---|---|---|
| a. Height | 10½ inches | 10-15/32 inches (panel) |
| b. Width | 17½ inches | 19 inches (panel) |
| c. Depth | 16 inches | 15-7/32 inches |
| d. Weight | 55 pounds | 55 pounds |

# SECTION 2
# OPERATION

## 2-1. GENERAL

The Du Mont Type 404 and 404-R Pulse Generators are shipped with all tubes in place and ready to operate.

Since these instruments are portable, no special installation procedure is required. The —R model has a front panel 19 inches wide by 10½ inches high for mounting in a standard relay rack or cabinet.

## 2-2. ENERGIZING THE EQUIPMENT

To place the instrument into operation, plug the power cord into the proper power source and push the reset button on the circuit breaker at the rear of chassis. Turn the power switch to ON and allow approximately one minute for the instrument to warm up.

## 2-3. OPERATING HINTS

### a. General

The operation of this unit is very simple. Connect a length of 50-ohm cable with a BNC plug at one end to the PULSE OUTPUT terminal. The other end should be terminated with a 50-ohm resistor either by the load impedance of the circuit receiving the pulse or by means of an appropriate terminating connector. Pulse width, amplitude, delay, and repetition rate are set according to the desire of the user.

### b. Cables and Termination

When dealing with fast, high quality pulses, the importance of impedance matching cannot be overemphasized. Interconnecting cables used with the Type 404 Pulse Generator must have 50-ohm characteristic impedance and must be terminated with a pure 50-ohm resistance in order to preserve optimum pulse waveform.

The method of termination and interconnection is also important. All junctions should be made up of coaxial plugs and connectors. Terminations should also be coaxial, even to the extent of using "T" connectors to provide plugged on terminations with a

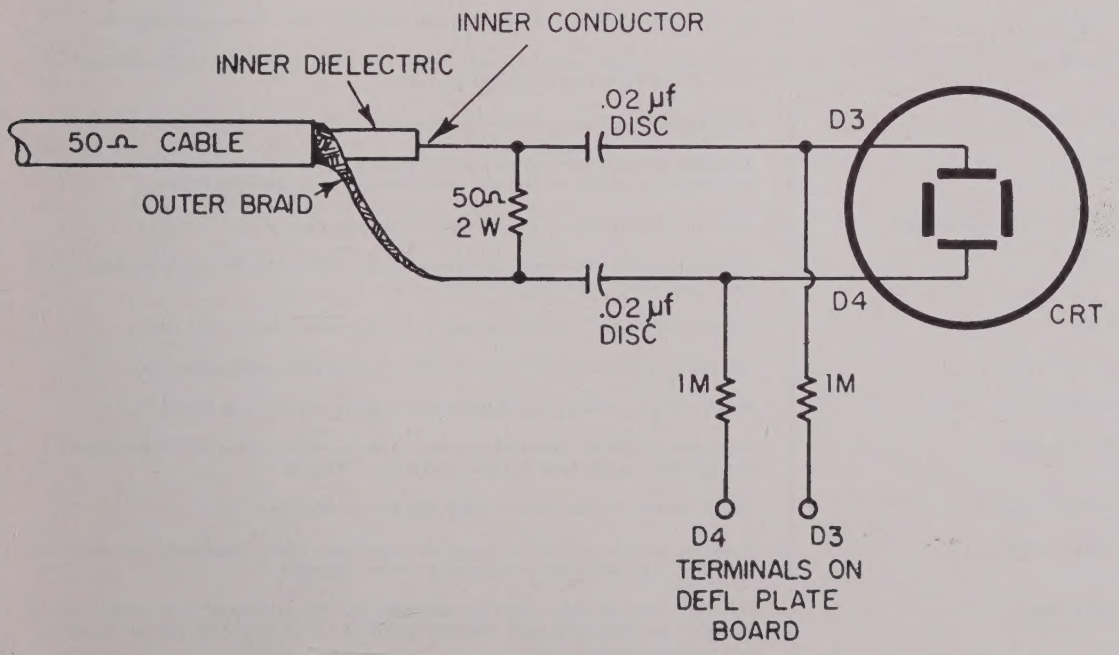



***Figure 2-1. Method for Viewing Pulses Direct at Cathode-ray Tube Plates***

minimum of discontinuities. Failure to observe these precautions can result in severe distortions of pulse waveshape.

### c. Pulse Width Calibration Adjustments

The complete pulse width calibration procedure is given in Maintenance, Table 4-2. However, reference to this procedure should be resorted to only if the instrument cannot be calibrated properly by means of the four front-panel screwdriver controls: 0.05, 1.0, 10, and 100 μsec controls. To make sure that the width of the pulse is in agreement with the front-panel markings, proceed as follows:

1) Connect a properly terminated cable between trigger OUTPUT and the external sync terminal of a cathode-ray oscillograph; and between PULSE OUTPUT and the vertical input of the cathode-ray oscillograph.

2) Set the μSEC dial to 1 and PULSE WIDTH MULTIPLIER to ×0.1.

## TABLE 2-1
## FRONT PANEL FACILITIES

| NAME | FUNCTION |
|---|---|
| TRIGGER POSITION μSEC | Control: used to delay the start of the OUTPUT PULSE up to 8 μsec or advance it up to 2 μsec with respect to the fixed delayed trigger OUTPUT |
| RATE RANGE—PPS | Switch: performs three functions—1) selects the internally generated triggers in decade steps from 10 to 100K pulses per second, 2) sets up the instrument for amplifying signals applied to EXT INPUT when switch is set to +EXT/MAN or —EXT, and 3) permits the instrument to be driven manually when switch is set to +EXT/MAN |
| RATE VERNIER | Control: provides continuous variation of the internal repetition rate within the limits established by the RATE RANGE—PPS switch |
| POLARITY | Switch: switches the fixed delayed trigger OUTPUT either positive or negative |
| MANUAL | Push-button switch: provides single trigger and pulse of selected width and amplitude when instrument is set for manual operation |
| EXT INPUT | Terminal: provides for a connection of external triggers |
| OUTPUT | Terminal: provides a positive or negative trigger, that has a fixed delay of 5 μsec with respect to either the internal rate generator or an external trigger |
| PULSE WIDTH MULTIPLIER | Switch: multiplies the μSEC dial settings in decade steps of 0.1, 1, and 10 |
| μSEC | Control: provides continuous variation of pulse width within the limits established by the PULSE WIDTH MULTIPLIER switch |
| 0.05 | Screwdriver control: used for setting up minimum pulse width—see text |
| 1, 10, & 100 | Screwdriver controls: used for setting up maximum pulse width—see text |
| ATTENUATOR | Rotary switch: provides decade reduction of pulse amplitude up to 50 db |
| ATTENUATOR | Push-button switches: used in conjunction with the rotary attenuator to enable reduction of pulse amplitude in 0.5 db increments to 59.5 db |
| PULSE POLARITY | Switch: switches PULSE OUTPUT either positive or negative |
| PULSE OUTPUT | Terminal: provides an output pulse of controllable width, amplitude, position, and repetition rate according to the desires of the operator |
| DUTY LIMIT | Indicator: flashing light warns the operator that the instrument is operating at its maximum specified duty cycle and that either the pulse amplitude and/or repetition rate must be reduced |
| Power ON | Toggle switch: applies primary power |

3) Adjust the 0.05 μsec control to obtain a minimum pulse width of exactly 0.1 microsecond as viewed on the cathode-ray oscillograph.
4) Set the μSEC dial to 10.
5) With the PULSE WIDTH MULTIPLIER set to ×0.1, adjust for a maximum pulse width of 1 microsecond by using the 1 μsec control.
6) Set PULSE WIDTH MULTIPLIER to ×1 and adjust for a maximum pulse width of 10 microseconds by using the 10 μsec control.
7) Set PULSE WIDTH MULTIPLIER to ×10 and adjust for a maximum pulse width of 100 microseconds by using the 100 μsec control.

#### d. Direct Connection To Deflection Plates (See Figure 2-1)

When applying pulses directly to the deflection plates of a cathode-ray tube, the shape of the pulse is not limited by the response of the built-in amplifier. Instead, it is dependent upon transmission line losses, input capacitance to the deflection plates terminals and/or transit time of the electron beam between the deflection plates. The need for proper termination is accentuated when viewing pulses direct on high-impedance deflection plates. In many cases, using the deflection plate terminals provided by cathode-ray oscillograph manufacturers is unsatisfactory because of the long leads from the terminal board to the deflection plates. Figure 2-1 indicates the proper hook-up for viewing pulses directly at the deflection plates of a cathode-ray tube.

#### e. Pulse Delay Extension

The Type 404 Pulse Generator does not normally exceed 8 microseconds of pulse delay. However, it is possible to extend this range by adding a capacitor in shunt with C218, the timing capacitor located in the pulse width delay multivibrator (V207). Extended pulse delays up to hundreds of microseconds can be obtained in this manner, providing the operator is aware of the 80% duty cycle limit imposed on the pulse delay circuit. Refer to Table 1-1, item 3c for additional information on pulse delay duty cycle.

### 2-4. FRONT-PANEL FACILITIES

The front-panel markings are essentially self explanatory, and after reading Table 2-1, the operator should be able to master the controls with a minimum of practice.

# SECTION 3
# THEORY OF OPERATION

## 3-1. GENERAL

The Type 404 Pulse Generator uses hard tubes for pulse generation. This instrument features repetition rates of 100,000 pulses per second; pulse widths from 0.05 to 100 microseconds, continuously variable; approximately 18 milli-microseconds transition time; and 50-volt output across a 50-ohm load with provisions for accurate control of amplitude in 0.5 db increments, up to 59.5 db.

An over-all functional block diagram of the instrument is shown in Figure 3-1 and a simplified timing diagram in Figure 3-2. It is recommended that the schematics at the rear of the manual be referred to in following the circuit description. For information on service adjustments, refer to Maintenance, Table 4-2.

To simplify circuit analysis, the instrument can be divided into five basic sections as follows: (1) Synchronizer, (2) Timing and Pulse Generator, (3) Pulse Driver and Output, (4) Attenuator, and (5) Power Supply and Heaters.

## 3-2. SYNCHRONIZER

### a. Internal Trigger Operation

The purpose of the synchronizer is twofold: 1) to produce a reference or starting trigger at time $t_0$ for subsequent initiation of the instrument, and 2) to produce an OUTPUT trigger having a fixed delay of approximately 5 microseconds with respect to the trigger at time $t_0$.

The internal rate generator (V101A & V101B) is a free-running multivibrator. Waveform **A** at the plate of this stage is differentiated by C115 and R114 and is clipped by CR101, resulting in waveform **B.** The leading edge of waveform **B** is coupled through the series triggering diode (V103A) to the output trigger delay multivibrator (V104) which generates waveforms **C** and **D.** Waveform **D** at the cathode of V104 has a fixed duration of approximately 5 microseconds and is differentiated by C119 and R123. The delayed positive trigger of waveform **E** is used to initiate a blocking oscillator (V105 and T101) which generates waveform **F.** Waveform **G** is the fixed delayed trigger OUTPUT occurring at time $t_1$, and is switched positive or negative by the POLARITY switch setting.

### b. External Trigger Operation

When the RATE CHANGE—PPS switch is set to —EXT or +EXT MAN, V101A and V101B are converted to a two-stage amplifier for amplifying signals applied to EXT INPUT.

V102A functions as a phase splitter and is switched into the circuit to precede the external trigger amplifier (V101A & V101B) when the instrument is set for external triggering. The phase splitter is operated as a class "A" amplifier with equal plate and cathode loads for equal positive and negative outputs. For external trigger operation, the output of V102A must always be negative in order to initiate the circuits which follow.

### c. Manual Operation

The Type 404 Pulse Generator can be driven manually at a repetition rate determined solely by the operator. Depressing the MANUAL push button provides a single pulse of selected width and amplitude. Circuit description is as follows: when the RATE RANGE—PPS switch is set to +EXT/MAN, the manual circuit is connected to the input of V101A. C101 is fully charged from the negative supply when the MANUAL button is out and is suddenly discharged through R105 when this button is actuated. The resulting negative impulse is amplified by V101A and V101B. From this point on, the instrument is driven through the pulse-generating cycle as explained elsewhere.

## 3-3. TIMING AND PULSE GENERATOR

### a. Pulse Delay Circuit

The purpose of the pulse delay circuit is to produce a trigger which occurs 2 to 12 microseconds after time $t_0$. This enables the start of the OUTPUT PULSE to be advanced up to 2 microseconds or delayed up to 8 microseconds with respect to the delayed OUTPUT trigger.

Waveform **B,** occurring at time $t_0$ is coupled through a series triggering diode (V103B) to the variable trigger position multivibrator (V201) which generates waveforms **H** and **I.** Actually this is the pulse delay circuit and the duration of this delay is made continuously variable by use of the TRIGGER POSITION control. Waveform **I** is differentiated by C205 and R209 which yields waveform **J.**

The trigger position buffer amplifier (V202) amplifies only the positive portion of waveform **J.** The amplified output is an isolated low-impedance negative trigger source for subsequent stages.

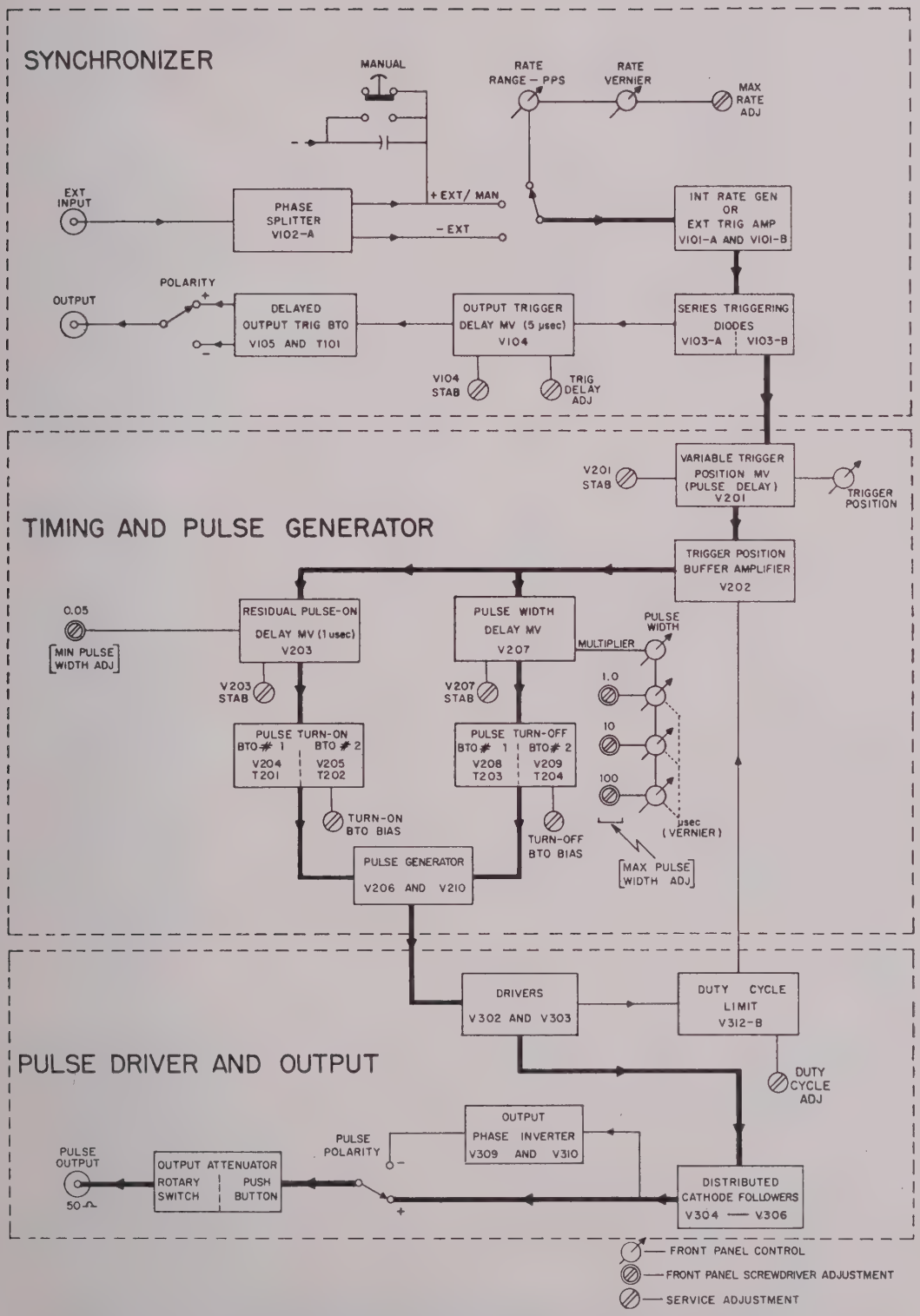



***Figure 3-1. Over-all Functional Block Diagram, Du Mont Type 404/404-R Pulse Generator***

#### b. Pulse Turn-On Circuit

Waveform **K** at the plate of V202 is used to simultaneously initiate the residual pulse-on multivibrator (V203) and the pulse width delay multivibrator (V207).

The residual pulse-on delay circuit was inserted to simplify setting the minimum pulse width to 0.05 microseconds. V203 generates waveforms **L** and **M** and the latter waveform is differentiated by C209 and R219 to obtain waveform **N.** The positive portion of waveform **N** is used to fire the pulse turn-on BTO #1 (V204 & T201), which in turn fires BTO #2 (V205 & T202). The purpose of the cascaded blocking oscillator stages is to create a very sharp, narrow trigger with which to turn on the normally nonconducting tube (V206) of the pulse generator. See waveform **O** through **T** inclusively.

#### c. Pulse Turn-Off Circuit

Some time after the pulse generator is turned on, the output from a similar pair of cascaded blocking oscillators (pulse turnoff BTO #1: V208 & T203; BTO #2: V209 & T204) are used to turn off the main pulse. The time of the turn off is determined by the trailing edge of the pulse width delay multivibrator (V207), whose duration is controlled from the front panel by the PULSE WIDTH MULTIPLIER and μSEC controls. See waveforms **J** through **Y** inclusively.

At this point, the action of the timing and initial pulse generation phases is complete with the net result consisting of a negative pulse with fast transitions, controllable duration and position. From this point on, the function of the remaining circuitry is to process the initial pulse by speeding up, clipping and impedance transformation.

### 3-4. PULSE DRIVER AND OUTPUT

#### a. Driver

The driver stage (V302 & V303) consists of a pair of power pentodes with the control grids clamped to zero bias. The screen grid voltage of this stage is derived from V301 and adjusted by R302 so the plates of V302 and V303 are drawing maximum allowable current.

When the negative pulse from the pulse generator (V206 & V210) appears at the control grids of V302 and V303, plate current is abruptly cut off resulting in a large positive pulse at the plates. See waveform **Z.**

The driver plate load consists of the input end of a lumped constant transmission line terminated in its characteristic impedance of 300 ohms. The line serves a dual function of 1) separating the input capacitance of the output stage from the driver plates, thereby preserving pulse rise time and 2) making possible the use of three low-cost tubes in parallel for the output stages.

#### b. Distributed Cathode Followers (see Figure 3-3)

Each of the grids of the distributed cathode followers (V304 to V306) is connected to a different point on the delay line, in sequence, and uniformly spaced, so that the signal at each grid arrives at a time slightly later than that of its predecessor. Correction for this time difference is made by lengths of coaxial cable. Operation of the circuit is as follows: Since the first tube (V304) on the delay line receives the signal first, it has the longest delay correction in its cathode. The second tube, V305, has only one-half the delay correction of V304, whereas V306 has no correction. Thus, when the three outputs meet at a common point, all three signals combine and are additive.

The parameters of each of the distributed cathode followers are adjusted for an average source impedance of 150 ohms so that the three cathodes in parallel result in the universally accepted 50-ohm source impedance.

Additional refinements for the preservation of pulse waveform are incorporated such as the limit resistor (R315, R318, & R323) in each distributed cathode-follower grid which enables a clipping action thereby serving to maintain a uniformly flat pulse top. Also, each screen grid is made to follow the cathode waveform by means of screen-to-cathode bypass capacitors (C306 to C308). By holding screen voltages constant with respect to the input signal, the Miller capacity is held to a minimum which further serves to reduce increases in rise time due to capacitive loading.

#### c. Output Phase Inverter

Provision for negative output pulses is made via an output phase inverter (V309 & V310) stage consisting of a pair of high perveance dual triodes in parallel, driven from the distributed cathode followers. Part of the phase inverter plate load consists of a group of ordinary 6.3-volt pilot light bulbs (I301 to I304) which serve as non-linear plate loads. Their function is to provide an increase in plate load as average current increases at high repetition rates, thereby serving to maintain constant amplitude negative pulses. Since the phase inverter grids are driven hard into conduction, changes of bias would result due to charging of the input coupling capacitor (C316). This is prevented by means of the phase

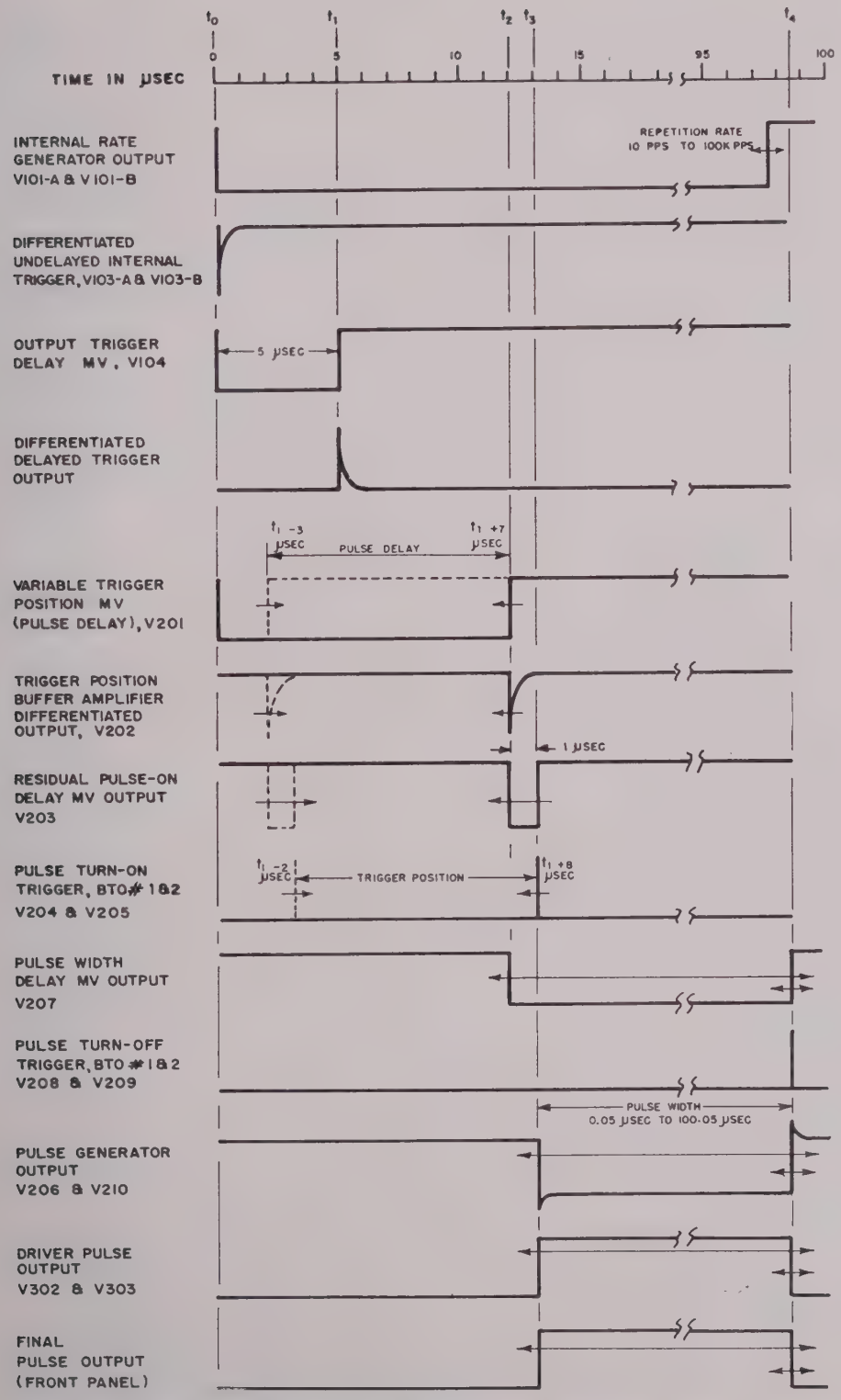

TIME IN μSEC
INTERNAL RATE GENERATOR OUTPUT V101-A & V101-B
REPETITION RATE 10 PPS TO 100K PPS
DIFFERENTIATED UNDELAYED INTERNAL TRIGGER, V103-A & V103-B
OUTPUT TRIGGER DELAY MV, V104
5 μSEC
DIFFERENTIATED DELAYED TRIGGER OUTPUT
PULSE DELAY
VARIABLE TRIGGER POSITION MV (PULSE DELAY), V201
TRIGGER POSITION BUFFER AMPLIFIER DIFFERENTIATED OUTPUT, V202
1 μSEC
RESIDUAL PULSE-ON DELAY MV OUTPUT V203
TRIGGER POSITION
PULSE TURN-ON TRIGGER, BTO # 1&2 V204 & V205
PULSE WIDTH DELAY MV OUTPUT V207
PULSE TURN-OFF TRIGGER, BTO # 1&2 V208 & V209
PULSE WIDTH 0.05 μSEC TO 100.05 μSEC
PULSE GENERATOR OUTPUT V206 & V210
DRIVER PULSE OUTPUT V302 & V303
FINAL PULSE OUTPUT (FRONT PANEL)

*Figure 3-2. Type 404/404-R Pulse Generator Simplified Timing Diagram*

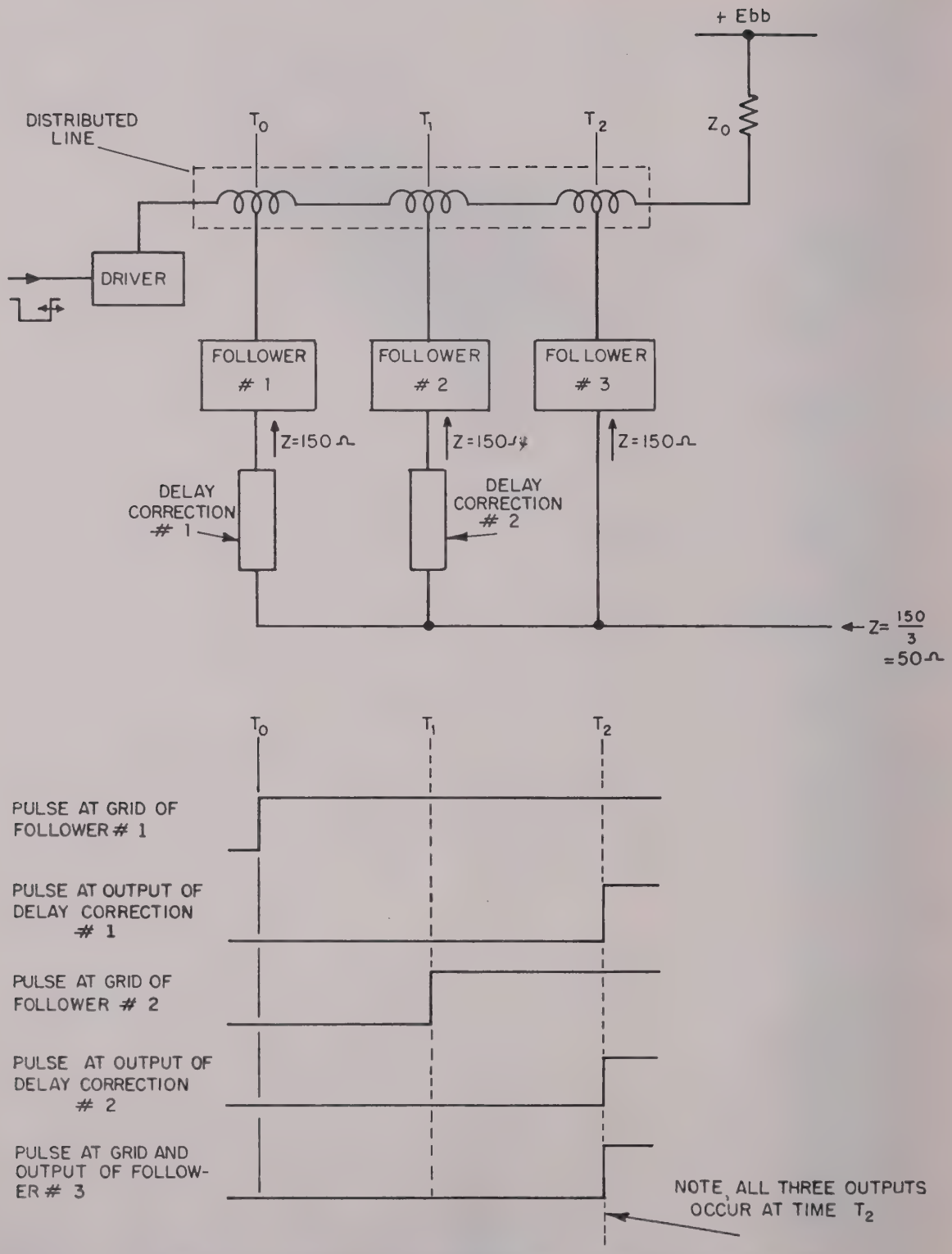



*Figure 3-3. Distributed Cathode Followers, Simplified Schematic*

inverter bias regulator (V311 & V312A) whose function is to maintain a constant, regulated bias source for V309 and V310.

#### d. Duty Cycle Limit

Some circuits in the Type 404 Pulse Generator operate with very high peak currents in the vicinity of two amperes. Consequently, it becomes necessary to limit the duty cycle to a point where the average power dissipation does not exceed safe tube and component rating. A positive safety feature has been incorporated to prevent operation beyond these ratings. This consists of an integrator circuit (C301 & R311) which compares pulse width to repetition rate. When the duty cycle reaches 10%, a relay (K301) is actuated which disconnects the screen voltage from V202, thus momentarily terminating operation. The operator is made physically aware of the danger point by an audible click and a warning light flash on the front panel (DUTY LIMIT). As soon as the pulses stop, the relay lets go allowing operation to resume. If nothing is done to lower the duty cycle, such as reducing pulse width or repetition rate, this process will continue at a rate determined by the amount that the duty cycle is being exceeded. In this way, the average power dissipation is automatically reduced to a safe value.

### 3-5. ATTENUATOR

A series of five 10 db attenuator steps are arranged in a ladder configuration so that only the first step requires high-wattage resistors; all of the other resistors used are standard one-half watt value. Six additional push button actuated attenuators provide sufficient small increments to enable a total attenuation range of 59.5 db in 0.5 db steps. The major advantage of this system is that a true impedance match does exist under any possible combination of attenuator settings, thereby minimizing distortion of pulse waveforms.

### 3-6. POWER SUPPLY

#### a. +250 Supply Voltage

The +250-volt supply uses two selenium rectifiers (CR501 & CR502) connected in a conventional voltage doubling circuit. Capacitors C501 and C502 are charged on alternate half cycles and are connected in series, thus yielding an output voltage that is twice the peak voltage of the ac supply (about 130 volts). This voltage is added to the output from the +130-volt rectifier making a total of approximately 260 volts, which is then applied to a conventional voltage regulator yielding +250 volts output.

#### b. +130 Supply Voltage

The +130-volt supply uses two selenium rectifiers (CR503 & CR504) connected in a conventional full-wave rectifier circuit. The rectified output is capacitively filtered (C505 to C507) and is applied to a conventional voltage regulator which yields +130 volts output.

#### c. —150 Supply Voltage

The —150-volt supply uses two selenium rectifiers (CR505 & CR506) connected as a voltage doubler. This circuit produces a result equivalent to that of a conventional voltage-doubling circuit except that it has the advantage of a high-source impedance. The rectified output is regulated by a gas diode (V506).

The instrument is protected by a 6-ampere circuit (CB501) located in the primary circuit.

# SECTION 4
# MAINTENANCE

### 4-1. GENERAL

The Type 404 Pulse Generator is enclosed in a cabinet which is composed of two removable covers (top and bottom). To gain access to the chassis, loosen the screws on top and sides of the desired cover and slip it out of the slotted holes. To gain access to the Type 404-R chassis, remove the dust cover.

**WARNING**

OBSERVE THE FOLLOWING PRECAUTIONS WHEN NECESSARY TO ENERGIZE THE EQUIPMENT WITH THE CABINET REMOVED:

1) Never work alone.
2) Make sure the chassis is properly grounded.
3) Remove power cord before changing any tubes.
4) Before touching any components, short the terminals to remove any possible charge that may remain after turning off the power.

### 4-2. SERVICE ADJUSTMENTS

*Do not touch any service adjustments* unless tests clearly indicate the need to do so. Such adjustments should not be attempted without a complete understanding of the proper procedure. Consult Tables 4-1 and 4-2 for special instructions. The procedures given in Table 4-2 are based on the assumption that no tubes or components are faulty. Whenever these conditions are not met, see paragraph 4-3, Servicing Hints.

### 4-3. SERVICING HINTS

In the event of improper equipment performance, the following suggestions are recommended:

1) Note that all tube heaters are lit.
2) Check all supply voltages; includes the ac power line, +250, +130, —150, and —7.5 volt levels.
3) *Do not tamper* with any of the service adjustments as this will only complicate servicing.
4) Localizing the trouble is made easier by use of a test probe coupled to a cathode-ray oscillograph. The correct waveforms are shown on the schematics. Each waveform is identified by a code letter to show the exact point at which it occurs.
5) Avoid short-circuiting any components with the test probe.
6) When a point is reached where normal performance ceases abruptly, a replacement tube should be tried before attempting any other tests. In some cases, a second new tube must be tried.
7) As a further aid to servicing, refer to Table 4-4: Symptoms of Tube Failure Chart.
8) Replacement of certain tubes will require resetting of one or more service adjustments. Consult Table 4-3. For optimum stability, the new tube should be allowed a warm-up time of at least one hour before making any final service adjustments.
9) If after tube replacement the trouble persists, replace the original tube in its socket and check for proper voltage and resistance per Tables 4-5 and 4-6.
10) Maintain a high quality of workmanship. Use a clean bench and soldering iron; keep solder joints smooth and bright; do not overheat any component while soldering.

## TABLE 4-1
## TEST EQUIPMENT REQUIRED FOR SERVICE ADJUSTMENTS

| REF. No. | DESCRIPTION | RANGE OR CHARACTERISTICS |
|---|---|---|
| (1) | Volt-ohmmeter | 20K ohms volt Test Meter |
| (2) | Cathode-ray Oscillograph | Du Mont Type 329-A Cathode-ray Oscillograph or equivalent; supplied with appropriate test probes |

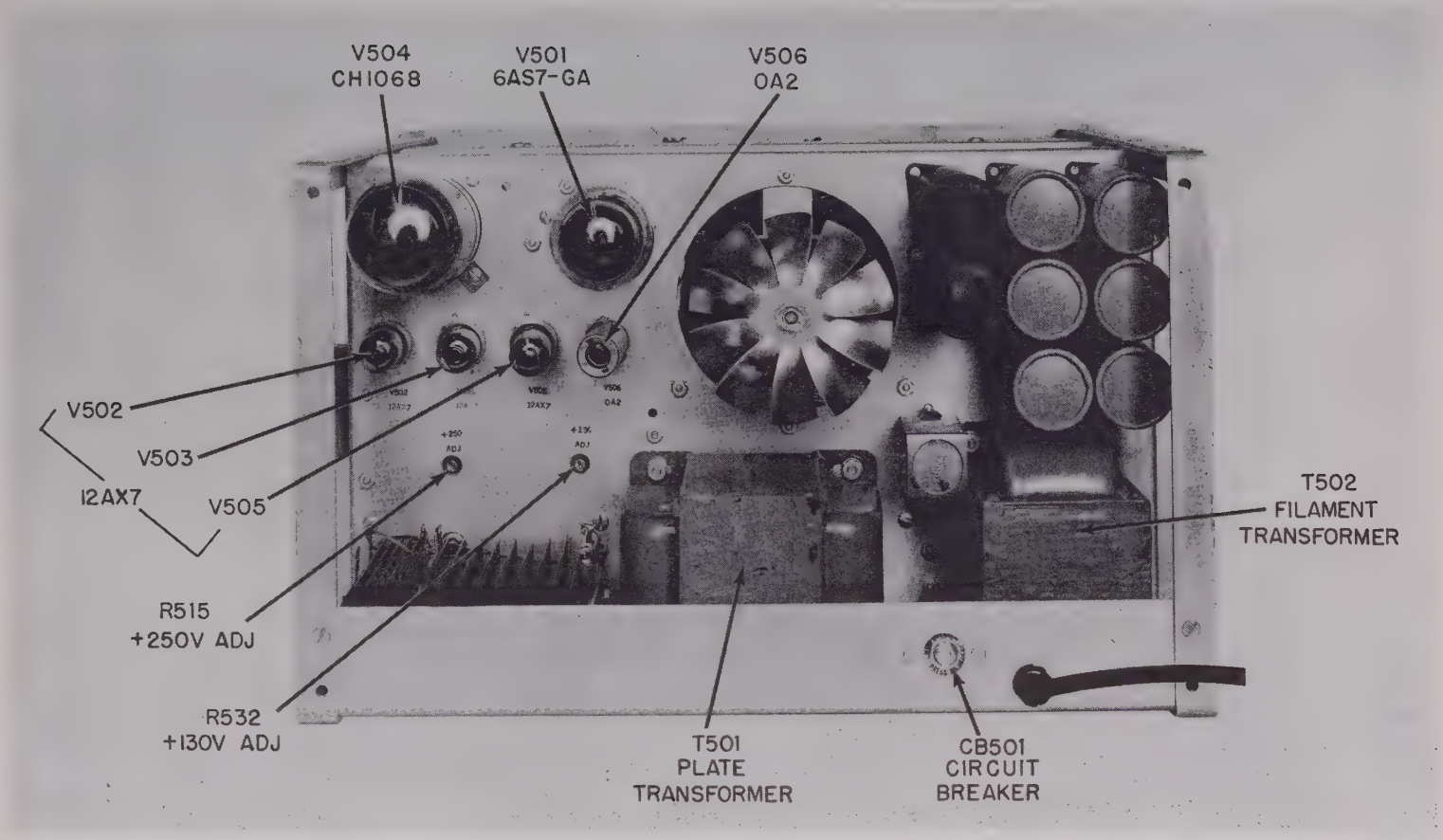



*Figure 4-1. Tubes and Adjustments, Rear View*

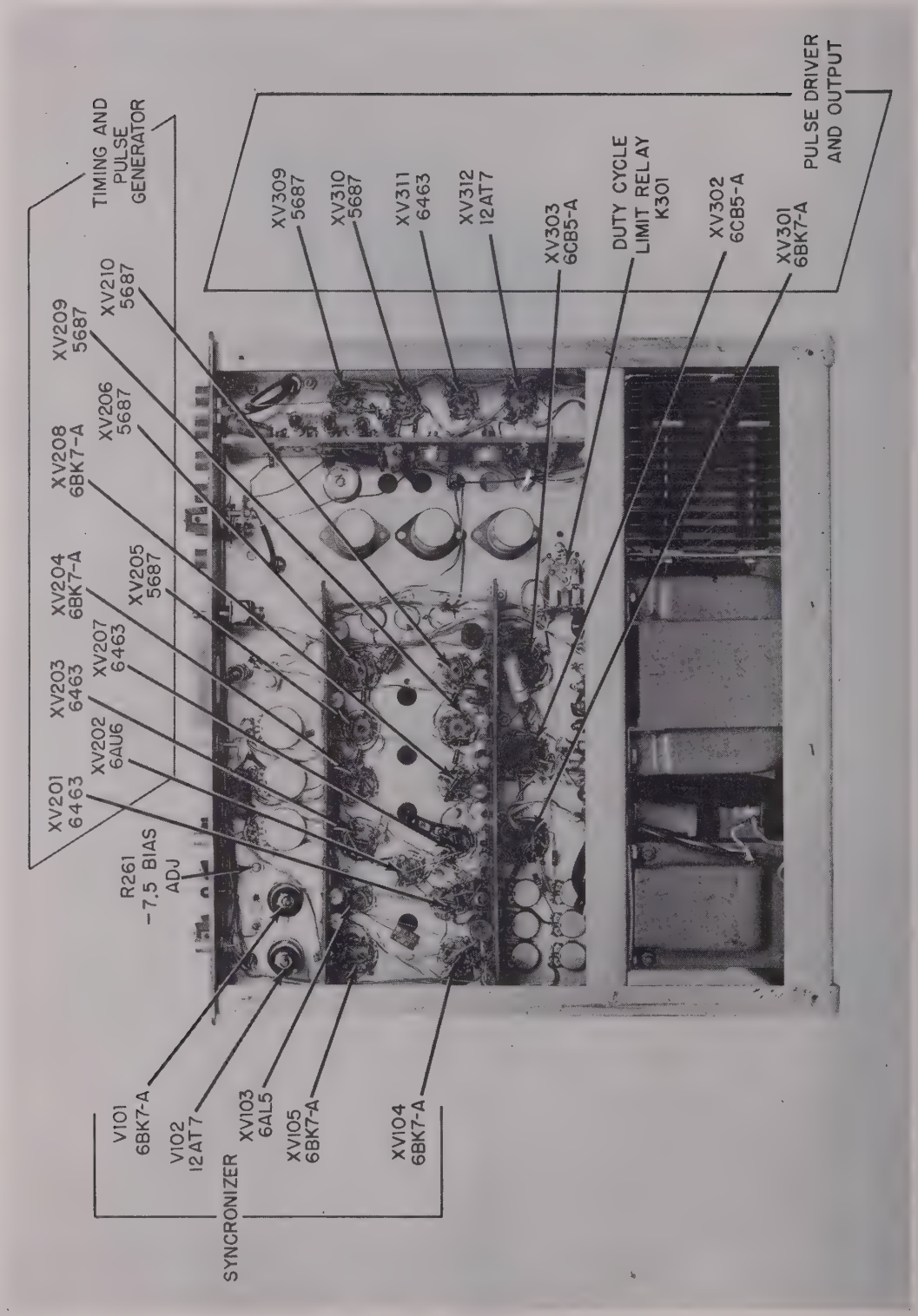



*Figure 4-2. Tubes and Adjustments, Bottom View*

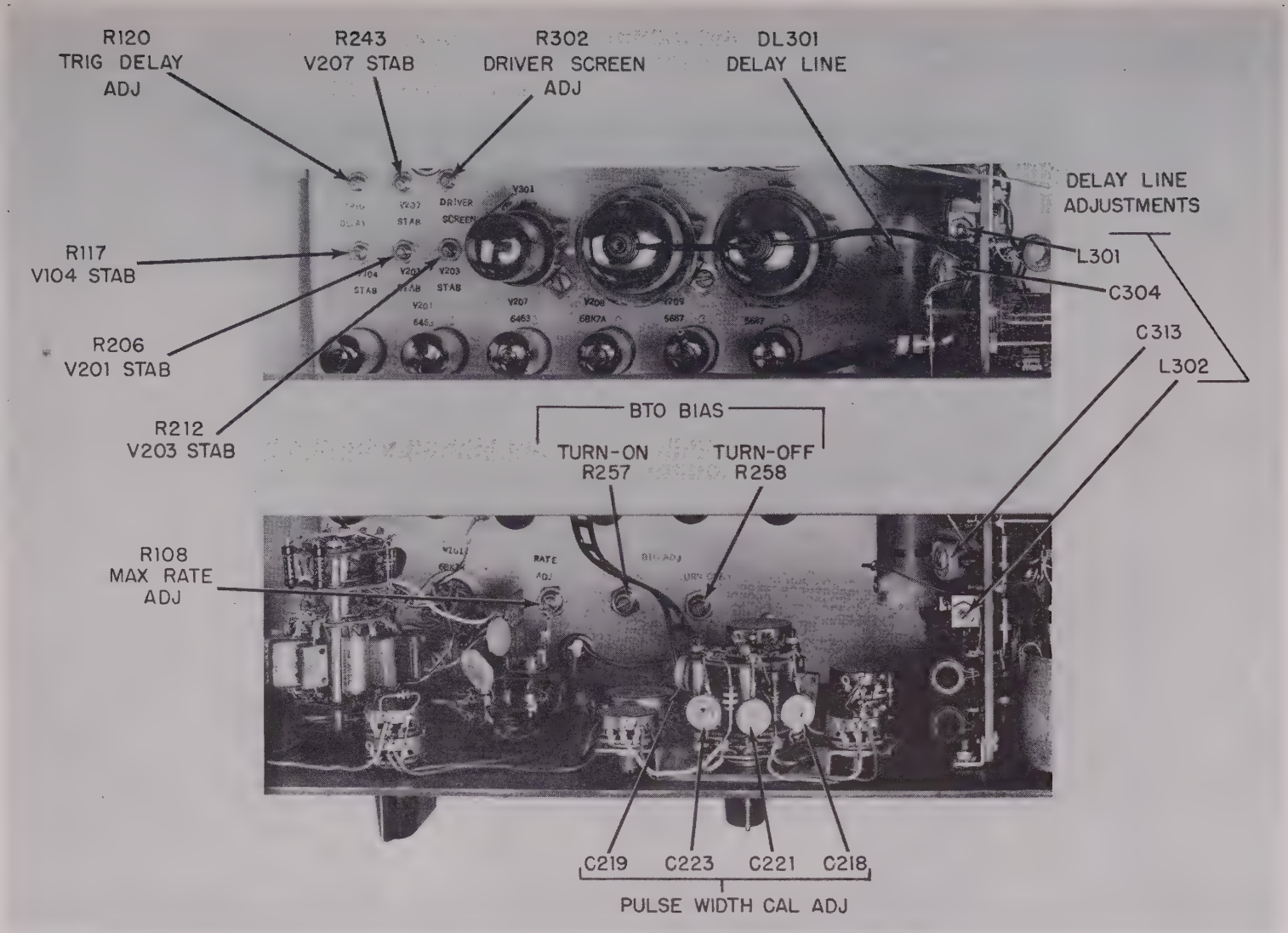



*Figure 4-3. Tubes and Adjustments, Top View*

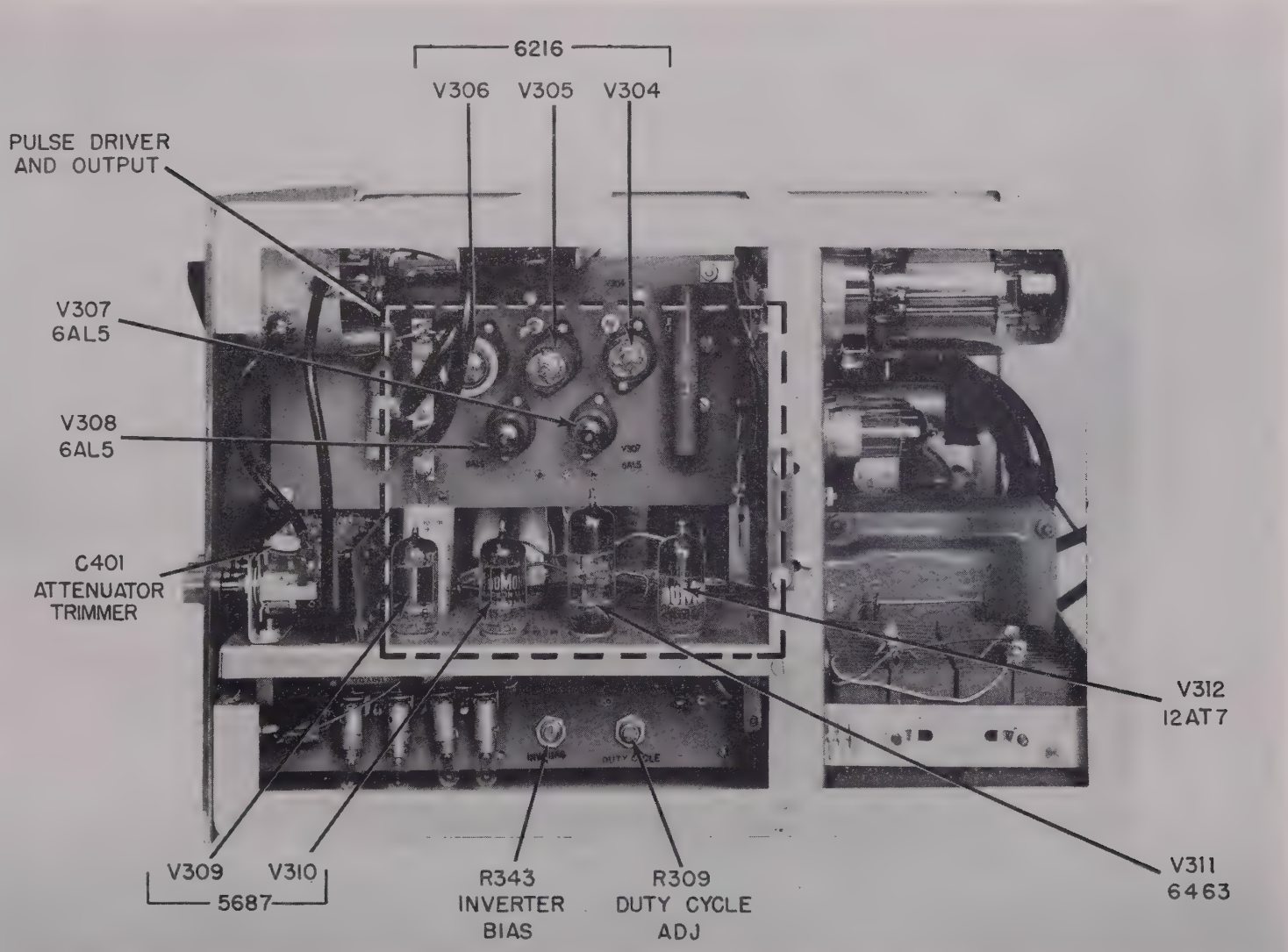



*Figure 4-4. Tubes and Adjustments, Right Side*

# TABLE 4-2
# SERVICE ADJUSTMENT CHART

**PRECAUTION**

DO NOT SET ANY SERVICE ADJUSTMENT WITHOUT FOLLOWING SPECIFIC INSTRUCTIONS AND SEQUENCE GIVEN IN TABLE 4-2. SOME ADJUSTMENTS ARE INTERDEPENDENT.

| NAME AND LOCATION | *TE | ADJUSTMENT PROCEDURE |
|---|---|---|
| +250V ADJ (R515) Fig. 4-1 | (1) | Connect a voltmeter from the insulated standoff next to V501 and ground. Adjust R515 for +250 volts |
| +130V ADJ (R532) Fig. 4-1 | (1) | Connect a voltmeter from tie point on V504 socket and ground. Adjust R532 for +130 volts |
| —7.5V ADJ (R261) Fig. 4-2 | (1) | Connect a voltmeter from pin 8 of V102B (negative) and ground. Adjust R261 for —7.5 volts |
| MAX RATE ADJ (R108) Fig. 4-3 | (2) | R108 is used to set the maximum internal trigger repetition rate to 100,000 pps<br>1. Connect a properly terminated cable between trigger OUTPUT and the input of a cathode-ray oscillograph<br>2. Set RATE RANGE—PPS to 100K, RATE VERNIER fully clockwise, and POLARITY to +<br>3. Adjust R108 for an interval of 10 μsec between triggers as viewed on the cathode-ray oscillograph |
| V104 STAB (R117) Fig. 4-3 | (2) | R117 is used to control the threshold bias of V104<br>1. Set TRIG DELAY ADJ (R120) fully clockwise<br>2. With an appropriate test probe connected to the input of a cathode-ray oscillograph, check waveform **D** while turning R117 clockwise<br>3. Set R117 to slightly below the point where instability occurs |
| V201 STAB (R206) Fig. 4-3 | (2) | R206 is used to control the threshold bias of V201<br>1. Set TRIGGER POSITION μSEC fully clockwise<br>2. Check waveform **I** while turning R206 clockwise<br>3. Set R206 to slightly below the point where instability occurs |
| V203 STAB (R212) Fig. 4-3 | (2) | R212 is used to control the threshold bias of V203<br>1. Set 0.05 μsec (minimum pulse width adjustment on front panel) fully counterclockwise<br>2. Check waveform **M** while turning R212 clockwise<br>3. Set R212 to slightly below the point where instability occurs |
| V207 STAB (R243) Fig. 4-3 | (2) | R243 is used to control the threshold bias of V207<br>1. Set PULSE WIDTH MULTIPLIER to X10 and μSEC (vernier) fully clockwise<br>2. Check waveform **V** while turning R243 clockwise<br>3. Set R243 to slightly below the point where instability occurs |
| Delay Line Adjustments (C304, L301, C313, L302); DRIVER SCREEN ADJ (R302) Fig. 4-3 | (2) | These adjustments are used to control the shape of the positive pulse<br>1. Connect a properly terminated cable from the PULSE OUTPUT terminal directly to the vertical deflection plates of a cathode-ray oscillograph |

* Number shown ( ) corresponds to reference number of test equipment in Table 4-1

## TABLE 4-2. SERVICE ADJUSTMENT CHART (Continued)

| NAME AND LOCATION | *TE | ADJUSTMENT PROCEDURE |
|---|---|---|
| | | 2. Set PULSE POLARITY to + |
| | | 3. Adjust C304, L301, C313, L302, and R302 for the best possible pulse waveshape |
| | | NOTE: It may be necessary to go back and forth several times, resetting each of the above adjustments until the best possible compromise in waveshape is reached |
| | | A good pulse is defined as one having the following characteristics: |
| | | a) Rise and fall time, 18 milli-μsec or better |
| | | b) Ring and overshoot on pulse top, less than 3% of pulse amplitude |
| | | c) Amplitude of pulse, 50 volts, ±10% |
| | | d) Minimum disturbance of base line following pulse fall time |
| INVERTER BIAS (R343)<br>Fig. 4-4 | (2) | R343 is used to control the shape of the negative pulse: it is adjusted after the first three steps above are completed |
| | | 4. Set PULSE POLARITY to — |
| | | 5. Adjust R343 for the best possible negative pulse |
| Attenuator Trimmer (C401)<br>Fig. 4-4 | (2) | C401 is used to preserve pulse waveshape |
| | | Adjust C401 for sharpness at beginning of pulse flat top with minimum possible ringing or overshoot |
| TRIG DELAY ADJ (R120)<br>Fig. 4-3 | (2) | R120 enables setting of pulse advance to 2 μsec (with respect to the internal delayed trigger OUTPUT) |
| | | 1. Connect a properly terminated cable between trigger OUTPUT and the external sync terminal of a cathode-ray oscillograph; and between PULSE OUTPUT and the vertical input of the cathode-ray oscillograph |
| | | 2. Set PULSE WIDTH MULTIPLIER and μSEC controls for a 2 μsec pulse |
| | | 3. Set TRIGGER POSITION fully counterclockwise |
| | | 4. Adjust R210 so that the trailing edge of the pulse is just barely visible at left edge of screen |
| DUTY CYCLE ADJ (R309)<br>Fig. 4-4 | — | R309 is used to set the maximum duty cycle of the instrument to 10% |
| | | 1. Set RATE RANGE—PPS to 100K, PULSE WIDTH MULTIPLIER and μSEC for a 1 μsec pulse |
| | | 2. Starting from the fully clockwise position, set R309 to the point where the duty cycle limit relay (K301) begins to click and the DUTY LIMIT indicator flashes |
| | | 3. Increasing the pulse width should increase relay clicking; decreasing pulse to less than 1 μsec should cause relay to stop clicking |
| Pulse Width Calibration Adjustments:<br>C223<br>Fig. 4-3 | (2) | C223 is used for calibrating the low end of the 1 μsec pulse range |
| | | 1. Set μSEC to 1, PULSE WIDTH MULTIPLIER to X0.1, and turn the 0.05 front-panel screwdriver control to center of range |
| | | 2. Adjust C223 to obtain a pulse width of 0.1 μsec as viewed on a cathode-ray oscillograph. This is a preliminary coarse adjustment |
| | | 3. Final vernier adjustment is made by the 0.05 control to give a pulse width of exactly 0.1 μsec |
| C221<br>Fig. 4-3 | (2) | C221 is used for calibrating the low end of the 10 μsec pulse range |
| | | 1. Set PULSE WIDTH MULTIPLIER to X1 |
| | | 2. Set C221 to obtain a pulse width of exactly 1 μsec |

* Number shown ( ) corresponds to reference number of test equipment in Table 4-1

## TABLE 4-2. SERVICE ADJUSTMENT CHART (Continued)

| NAME AND LOCATION | *TE | ADJUSTMENT PROCEDURE |
|---|---|---|
| C218 & C219<br>Fig. 4-3 | (2) | C218 and C219 are used for calibrating the low end of the 100 μsec pulse range<br>1. Set PULSE WIDTH MULTIPLIER to X10<br>2. Set C218 and/or C219 to give a pulse width of exactly 10 μsec |
| 1.0, 10, & 100 μsec | (2) | These front-panel screwdriver controls are used to calibrate the high end of their respective pulse ranges<br>1. Set μSEC dial to 10<br>2. Set PULSE WIDTH MULTIPLIER to X0.1; adjust the "1" control to obtain a pulse width of 1 microsecond<br>3. Set PULSE WIDTH MULTIPLIER to X1; adjust the "10" control to obtain a pulse width of 10 microseconds<br>4. Set PULSE WIDTH MULTIPLIER to X10; adjust the "100" control to obtain a pulse width of 100 microseconds |

* Number shown ( ) corresponds to reference number of test equipment in Table 4-1

## TABLE 4-3
## ADJUSTMENTS TO BE MADE WHEN REPLACING TUBES

| SYMBOL | TYPE | SERVICE ADJUSTMENTS TO BE CHECKED (See Table 4-2) |
|---|---|---|
| **SYNCHRONIZER** | | |
| V101 | 6BK7-A | MAX RATE ADJ (R108) |
| V102 | 12AT7 | —7.5V BIAS ADJ (R261) |
| V103 | 6AL5 | None |
| V104 | 6BK7-A | V104 STAB (R117) and TRIG DELAY ADJ (R120) |
| V105 | 6BK7-A | None |
| **TIMING AND PULSE GENERATOR** | | |
| V201 | 6463 | V201 STAB (R206) |
| V202 | 6AU6 | None |
| V203 | 6463 | V203 STAB (R212) and 0.05 μsec (R214) |
| V204 | 6BK7-A | None |
| V205 | 5687 | TURN-ON BTO BIAS (R257) |
| V206 | 5687 | None |
| V207 | 6463 | V207 STAB (R243); all pulse width calibration adjustments, includes: 1, 10, and 100 μsec (front panel); C218, C219, C221 and C223 |
| V208 | 6BK7-A | None |
| V209 | 5687 | TURN-OFF BTO BIAS (R258) |
| V210 | 5687 | None |
| **PULSE DRIVER AND OUTPUT** | | |
| V301 | 6BX7-GT | DRIVER SCREEN ADJ (R302) |
| V302 & V303 | 6CB5-A | Delay Line Adjustments (L301, L302, C304, and C313) |
| V304 to V306 | 6216 | Delay Line Adjustments (L301, L302, C304, and C313) |
| V307 & V308 | 6AL5 | None |
| V309 & V310 | 5687 | INVERTER BIAS (R343) |
| V311 & V312 | 6463 | INVERTER BIAS (R343) |
| **POWER SUPPLY** | | |
| V501 | 6AS7-GA | +250V ADJ (R515) |
| V502 | 12AX7 | +250V ADJ (R515) |
| V503 | 12AX7 | +250V ADJ (R515) and +130V ADJ (R532) |
| V504 | CH1068 | +130V ADJ (R532) |
| V505 | 12AX7 | +130V ADJ (R532) |
| V506 | OA2 | None |

# TABLE 4-4
# SYMPTOMS OF TUBE FAILURE CHART

NOTES: 1. Some of the symptoms indicated in this table might be caused by the misalignment of service adjustments or failure of some component associated with the circuit under analysis.

2: The waveforms mentioned in the table are shown on the schematic. Each waveform is identified by a code letter to show the exact point at which it occurs.

| TUBE SYMBOL | SYMPTOMS OF TUBE FAILURE |
|---|---|
| | **SYNCHRONIZER** |
| V101 | a. No OUTPUT triggers<br>b. No response to triggers applied to EXT INPUT<br>c. No waveform at **A** |
| V102A<br>V102B | a. Equipment operation is normal except there is no response to triggers applied to EXT INPUT<br>b. The —7.5 BIAS ADJ (R261) is improperly set; see Table 4-2. If this bias level is set too high, the BTO stages (V204 and V208) will be inoperative |
| V103A<br>V103B | a. No OUTPUT triggers<br>b. Satisfactory waveform at **B**, nothing at **C**; hence the output trigger delay multivibrator (V104) is not receiving the initiating trigger<br>c. No PULSE OUTPUT<br>d. Satisfactory waveform at **B**, nothing at **H**; hence the variable trigger position multivibrator (V201) is not receiving the initiating trigger |
| V104 | a. No OUTPUT triggers<br>b. Satisfactory waveform at **B**; improper or no waveform at **C** and/or **D** |
| V105 | a. No OUTPUT triggers<br>b. Satisfactory waveform at **D** and **E**; none at **F** or **G** |
| | **TIMING AND PULSE GENERATOR** |
| V201 | a. No PULSE OUTPUT<br>b. OUTPUT triggers are satisfactory; see waveform **G**<br>c. No waveform at **J** input to trigger position buffer amplifier (V202)<br>d. Intermittent performance of MANUAL triggering system can also be traced to either V201 or improper adjustment of V201 STAB (R206) |
| V202 | a. No PULSE OUTPUT<br>b. Satisfactory waveform at the control grid **J**; nothing at the plate **H**<br>c. Defective duty cycle relay (K301) may also cause this stage to be inoperative (check screen grid voltage of V202) |
| V203 to V205 | a. No PULSE OUTPUT<br>b. Loss of PULSE OUTPUT at high repetition rates |
| V206 | a. No PULSE OUTPUT<br>b. Poor pulse waveform<br><br>NOTE: This tube is the normally-off half of the multivibrator. Under no circumstances should the instrument be allowed to remain in operation, if the normally-on half (V210) of the multivibrator is removed from its socket or is known to be defective. |
| V207 to V209 | a. Pulse width approximately 150 μsec<br>b. PULSE WIDTH MULTIPLIER control is inoperative |
| V210 | a. No PULSE OUTPUT<br>b. Poor pulse waveform<br>c. Cannot adjust the instrument for a minimum pulse width of 0.05 microsecond<br>d. Check waveforms **L** through **Y** inclusively |

## TABLE 4-4
## SYMPTOMS OF TUBE FAILURE CHART (Continued)

| TUBE SYMBOL | SYMPTOMS OF TUBE FAILURE |
|---|---|
| | **PULSE DRIVER AND OUTPUT** |
| V301 | a. No PULSE OUTPUT<br>b. Continuous operation of duty cycle relay (K301) |
| V302 & V303 | a. No PULSE OUTPUT<br>b. Continuous operation of duty cycle relay (K301)<br>c. Unsatisfactory waveform at plates of V302 and V303 **Z** |
| V304 to V306 | a. Unsatisfactory PULSE OUTPUT waveform<br>b. Insufficient pulse amplitude |
| V307 & V308 | a. Unsatisfactory PULSE OUTPUT waveform |
| V309 & V310 | a. Positive PULSE OUTPUT is satisfactory<br>b. Unsatisfactory negative PULSE OUTPUT waveform |
| V311 | a. Unsatisfactory negative PULSE OUTPUT<br>b. Insufficient pulse amplitude<br>c. Amplitude of negative pulse is over-sensitive to variations in the repetition rate |
| V312A | a. Unsatisfactory negative PULSE OUTPUT<br>b. I301 through I304 are brilliantly lit<br>NOTE: This instrument should not be allowed to remain in operation when V312 is removed from its socket or is known to be defective |
| V312B | c. Defective performance of duty cycle limit circuit |
| | **POWER SUPPLY AND HEATER CIRCUITS** |
| V501 & V502 | a. +250 supply voltage is too low; poor regulation<br>b. +130 supply voltage is also affected<br>c. Excessive ripple or oscillations |
| V503A & V503B | a. +250 supply voltage is too high; poor regulation<br>b. +130 supply voltage is too high; poor regulation<br>c. Excessive ripple or oscillations |
| V504 & V505 | a. +130 supply voltage is too low; poor regulation<br>b. +250 supply voltage is normal<br>c. Excessive ripple or oscillations |
| V506 | a. —150 supply voltage is too high<br>b. Excessive ripple or oscillations in —150-volt supply<br>c. Both the +250 and —130 supply voltages are too high<br>NOTE: The instrument should not be allowed to operate under these conditions |
| CR501 & CR502 | a. Same as V501 |
| CR 503 & CR504 | a. Same as V501 or V504 |
| CR505 & CR506 | a. V506 does not glow<br>b. —150 supply voltage is too low<br>c. +250 and +130 supply voltages are too low |

# TABLE 4-5
# VOLTAGE MEASUREMENTS

NOTES: 1. All voltages measured with a 20K-ohm/ voltmeter; measurements taken from tube socket to chassis
2. All voltages are dc and positive with respect to chassis, except where otherwise indicated
3. All measurements taken with RANGE RATE-PPS set to +EXT/MAN
4. *Indicates measurement with VTVM

| SYMBOL | TYPE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | **SYNCHRONIZER** | | | | | |
| | NOTES: 5. Tube socket voltage variation is indicated as follows: a) Varies with V104 STAB (R117) | | | | | | | | | |
| V101 | 6BK7-A | 50 | 0.5 | 0 | 0 | 6.3ac | 128 | —7 | 0 | 0 |
| V102 | 12AT7 | 125 | *4.5 | 5 | 0 | 0 | 130 | —8.5 | —7.5 | 6.3ac |
| V103 | 6AL5 | 130 | 130 | 0 | 6.3ac | 130 | 0 | 130 | ..... | ..... |
| V104 | 6BK7-A | 130 | a) 52 | 57 | 0 | 6.3ac | 130 | 57 | 57 | 0 |
| V105 | 6BK7-A | 250 | —7.5 | 2.5 | 0 | 6.3ac | 250 | —7.5 | 0 | 0 |
| | | | | | **TIMING AND PULSE GENERATOR** | | | | | |
| | NOTES: 6. Tube socket voltage variations are indicated as follows: a) Varies approximately 10 volts over range of TRIGGER POSITION control b) Varies with V201 STAB (R206) c) Screen voltage to pin 6, V202, comes via relay (K301) shown on Pulse Driver and Output schematic. When pulse duty cycle exceeds 10%, this voltage is intermittently switched off and on d) Varies with 0.05 μsec (min pulse width adj) on front panel e) Varies with V203 STAB (R212) f) Varies with TURN-ON BTO BIAS (R257) g) Varies with μSEC (Pulse Width Vernier) control h) Varies with V207 STAB (R243) j) Varies with TURN-OFF BTO BIAS (R258) | | | | | | | | | |
| V201 | 6463 | 110 | a) 37 | a) 37 | 0 | 0 | 130 | a) 37 | b) 18 | 6.3ac |
| V202 | 6AU6 | —7.5 | 0 | 0 | 6.3ac | 130 | | 0 | . . | |
| V203 | 6463 | 110 | d) 37 | d) 37 | 0 | 0 | 130 | d) 37 | e) 18 | 6.3ac |
| V204 | 6BK7-A | 250 | —7.5 | 0 | 0 | 6.3ac | 250 | —7.5 | 0.5 | 0 |
| V205 | 5687 | 250 | .. ... | —45 | 0 | 0 | 12 | – 7.5 | 6.3ac | 250 |
| V206 | 5687 | 130 | —45 | 0 | 0 | 0 | 0 | -—45 | 6.3ac | 130 |
| V207 | 6463 | 110 | g) 37 | g) 37 | 0 | 0 | 130 | g) 37 | h) 18 | 6.3ac |
| V208 | 6BK7-A | 250 | —7.5 | 0.1 | 0 | 6.3ac | 250 | —7.5 | 0 | 0 |
| V209 | 5687 | 250 | —7.5 | 12 | 0 | 0 | 2 | —60 | 6.3ac | 250 |
| V210 | 5687 | 60 | 2 | 0 | 0 | 0 | 0 | 2 | 6.3ac | 60 |

## TABLE 4-5. VOLTAGE MEASUREMENTS (Continued)

| SYMBOL | TYPE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **PULSE DRIVER AND OUTPUT** | | | | | | | | |
| | NOTES: 6. Tube socket voltage variations are indicated as follows:<br>a) Varies with DRIVER SCREEN ADJ (R302)<br>b) Indicates plate cap reading—not pin 9<br>c) Varies with INVERTER BIAS (R343)<br>d) Varies with DUTY CYCLE ADJ (R309) and with duty cycle while operating | | | | | | | | | |
| V301 | 6BX7-GT | a) 65 | 130 | a) 70 | a) 65 | 130 | a) 70 | 0 | 6.3ac | . .. |
| V302 | 6CB5 | a) 70 | 0 | 0 | 0.75 | 0.75 | 0 | 6.3ac | a) 70 | a, b) 45 |
| V303 | 6CB5 | a) 70 | 0 | 0 | 0.75 | 0.75 | 0 | 6.3ac | a) 70 | a, b) 45 |
| V304 | 6216 | 250 | a) 45 | a) 65 | 0 | 6.3ac | 250 | 250 | a) 65 | |
| V305 | 6216 | 250 | a) 45 | a) 65 | 0 | 6.3ac | 250 | 250 | a) 65 | ..... |
| V306 | 6216 | 250 | a) 45 | a) 65 | 0 | 6.3ac | 250 | 250 | a) 65 | .. .. |
| V307 | 6AL5 | ..... | 250 | 0 | 6.3ac | 250 | 0 | . ... | ..... | . . |
| V308 | 6AL5 | 250 | 250 | 0 | 6.3ac | 250 | 0 | 250 | ..... | ..... |
| V309 | 5687 | 130 | c) —10 | 0 | 0 | 0 | 0 | c) —10 | 6.3ac | 130 |
| V310 | 5687 | 130 | c) —10 | 0 | 0 | 0 | 0 | c) —10 | 6.3ac | 130 |
| V311 | 6463 | 130 | c) —10 | c) —22* | 0 | 0 | 130 | c) —10 | c) —22* | 6.3ac |
| V312 | 12AT7 | c) 22 | c) 0.1 | 0 | 0 | 0 | 250 | d) 10 | d) 13 | 6.3ac |
| | | **POWER SUPPLY** | | | | | | | | |
| V501 | 6AS7-GA | 230 | 340 | 250 | 230 | 340 | 250 | 0 | 6.3ac | . .. |
| V502 | 12AX7 | 80 | 0 | 1 | 0 | 0 | *155 | *—0.6 | 1 | 6.3ac |
| V503 | 12AX7 | 230 | —3 | 0 | 0 | 0 | 120 | —1.5 | 0 | 6.3ac |
| V504 | CH1068 | 0 | 134 | 134 | 134 | 120 | 210 | 6.3ac | | |
| V505 | 12AX7 | 80 | 0 | 1 | 0 | 0 | *155 | *—0.6 | 1 | 6.3ac |
| V506 | 0A2 | 0 | —150 | ..... | —150 | 0 | ..... | —150 | .. | ..... |

# TABLE 4-6
# RESISTANCE MEASUREMENTS

NOTES: 1. All resistance measurements taken from tube socket to chassis
2. K= 1,000 ohms; M = megohm

| SYMBOL | TYPE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | **SYNCHRONIZER** | | | | | | |
| | | NOTES: 3. Tube socket resistance variations are indicated as follows:<br>a) Varies with RATE VERNIER control setting<br>b) Depends on meter polarity<br>c) Varies with V104 STAB (R117)<br>d) Varies with TRIG DELAY ADJ (R120) | | | | | | | | |
| V101 | 6BK7-A | 16K | a) 200K-2M | 0 | 0.5 | 0.5 | 16K | a) 200K-2M | 0 | 0 |
| V102 | 12AT7 | 40K | 390K | 1K | 0 | 0 | 4K | 12K | 13.K | 0.5 |
| V103 | 6AL5 | b) 4K/20K | 10K | 0 | 0.5 | b) 4K/20K | 0 | 10K | | .. |
| V104 | 6BK7-A | 10K | c) 22K-32K | 5.6K | 0 | 0.5 | 4K | d) 2M-4.5M | 5.6K | 0 |
| V105 | 6BK7-A | 15K | 1.5K | 470 | 0 | 0.5 | 15K | 3.5K | 0 | 0 |
| | | | | **TIMING AND PULSE GENERATOR** | | | | | | |
| | | NOTES: 4. Tube socket resistance variations are indicated as follows:<br>a) Varies with TRIGGER POSITION control setting<br>b) Varies with V201 STAB (R206)<br>c) Varies with 0.05 µsec (min pulse width adj) on front panel<br>d) Depends on meter polarity<br>e) Varies with V203 STAB (R212)<br>f) Varies with PULSE WIDTH MULTIPLIER and µsec (Vernier) control settings<br>g) Varies with V207 STAB (R243)<br>h) Varies with TURN-OFF BTO BIAS (R258) | | | | | | | | | |
| V201 | 6463 | 5K | 1.5K | a) 120K-600K | 0 | 0 | 10K | 1.6K | b) 0-250K | 0.5 |
| V202 | 6AU6 | 3.5K | 0 | 0 | 0.5 | 4K | 4K | 0 | ----- | ----- |
| V203 | 6463 | 5K | 1.5K | c) 150K-200K | 0 | 0 | d) 4K/10K | 1.6K | e) 0-25K | 0.5 |
| V204 | 6BK7-A | 15K | 3.5K | 0 | 0 | 0.5 | 15K | 1.3K | 390 | 0 |
| V205 | 5687 | 15K | 7K | 20K | 0 | 0 | 1K | 1.3K | 0.5 | 15K |
| V206 | 5687 | 4.3K | 20K | 0 | 0 | 0 | 0 | 20K | 0.5 | 4.3K |
| V207 | 6463 | 5K | 1.5K | f) 150K-5M | 0 | 0 | d) 4K/10K | 1.6K | a) 0-25K | 0.5 |
| V208 | 6BK7-A | 15K | 1.3K | 47 | 0 | 0.5 | 15K | 3.5K | 0 | 0 |
| V209 | 5687 | 15K | 1.3K | 1K | 0 | 0 | 60K | h) 1.5K-7.5K | 0.5 | 15K |
| V210 | 5687 | 15K | 60K | 0 | 0 | 0 | 0 | 60K | 0.5 | 15K |

## TABLE 4-6. RESISTANCE MEASUREMENTS (Continued)

| SYMBOL | TYPE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | **PULSE DRIVER AND OUTPUT** | | | | | |
| | | NOTES: 5. Tube socket resistance variations are indicated as follows: a) Indicates plate cap reading—not pin 9 b) Varies with DUTY CYCLE ADJ (R309) | | | | | | | | |
| V301 | 6BK7-GT | 18K | 4K | Inf | 18K | 4K | Inf | .0 | 0.5 | .. |
| V302 | 6CB5 | Inf | 0 | 0 | 50K | 50K | 0 | 0.5 | Inf | a) 4.3K |
| V303 | 6CB5 | Inf | 0 | 0 | 50K | 50K | 0 | 0.5 | Inf | a) 4.3K |
| V304 | 6216 | 15K | 4.5K | 750 | 0 | 0.5 | 15K | Inf | 750 | ..... |
| V305 | 6216 | 15K | 4.5K | 750 | 0 | 0.5 | 15K | Inf | 750 | ..... |
| V306 | 6216 | 15K | 4.5K | 750 | 0 | 0.5 | 15K | Inf | 750 | ..... |
| V307 | 6AL5 | ..... | 15K | 0 | 0.5 | Inf | 0 | ..... | ..... | ..... |
| V308 | 6AL5 | Inf | 15K | 0 | 0.5 | Inf | 0 | 15K | ..... | ..... |
| V309 | 5687 | 4K | 80K | 0 | 0 | 0 | 0 | 80K | 0.5 | 4K |
| V310 | 5687 | 4K | 80K | 0 | 0 | 0 | 0 | 80K | 0.5 | 4K |
| V311 | 6463 | 4K | 80K | 60K | 0 | 0 | 4K | 80K | 60K | 0.5 |
| V312 | 12AT7 | 45K | 50K | 0 | 0 | 0 | 15K | 1M | b) 1K-3.5K | 0.5 |
| | | | | | **POWER SUPPLY** | | | | | |
| V501 | 6AS7-GA | 1M | 20K | 15K | 1M | 20K | 15K | 0 | 0.5 | ..... |
| V502 | 12AX7 | 800K | 0 | 400K | 0 | 0 | 400K | 200K | 400 K | 0.5 |
| V503 | 12AX7 | 1M | 1M | 0 | 0 | 0 | 480 K | 1M | 0 | 0.5 |
| V504 | CH1068 | 0 | 4K | 4K | 4K | 580K | 20K | 0.5 | ..... | ..... |
| V505 | 12AX7 | 800K | 0 | 400K | 0 | 0 | 400K | 200K | 400K | 0.5 |
| V506 | OA2 | 0 | 10K | ..... | 10K | 0 | ..... | 10K | ..... | ..... |

# SECTION 5
# ELECTRICAL PARTS LIST AND SCHEMATICS

| Symbol | Part Number | Description |
|---|---|---|
| | **BLOWER** | |
| B501 | 8100 3501 | motor |
| — | 8100 3600 | blade |
| | **CAPACITORS** | |
| | (all capacitors are fixed, ceramic, 500 V unless otherwise specified) | |
| C101 to C104 | 0312 2430 | 0.02 μf, +100 —0% |
| C105 | 0316 2550 | paper, 0.25 μf, ±10%, 400 V |
| C106 | 0305 5130 | mica, 68 μμf, ±5% |
| C107 | 0302 9200 | mica, 680 μμf, ±5% |
| C108 | 0302 9550 | mica, 6800 μμf, ±10%, 300 V |
| C109 | 0317 7610 | paper, 0.068 μf, ±5%, 200 V |
| C111 | 0317 7610 | paper, 0.068 μf, ±5%, 200V |
| C112 | 0302 9550 | mica, 6800 μμf, ±10%, 300 V |
| C113 | 0302 9200 | mica, 680 μμf, ±5% |
| C114 | 0305 5130 | mica, 68 μμf, ±5% |
| C115 | 0315 2010 | 150 μμf, ±20% |
| C116 | 0313 1040 | paper, 0.5 μf, ±20%, 200V |
| C117 | 0305 5360 | mica, 15 μμf, ±5% |
| C118 | 0316 2550 | paper, 0.25 μf, ±10%, 400 V |
| C119 | 0315 2010 | 150 μμf, ±20% |
| C122 | 0312 2430 | 0.02 μf, +100 —0% |
| C123 | 0313 1040 | paper, 0.5 μf, ±20%, 200 V |
| C124 | 0312 2430 | 0.02 μf, +100 —0% |
| C201 | 0313 1040 | paper, 0.5 μf, ±20%, 200 V |
| C202 | 0305 5170 | mica, 100 μμf, ±5% |
| C203 & C204 | 0315 6600 | 470 μμf, ±20%, 1000 V |
| C205 | 0315 2010 | 150 μμf, ±20% |
| C206 | 0315 6600 | 470 μμf, ±20%, 1000 V |
| C207 | 0305 5010 | mica, 22 μμf ±5% |
| C208 | 0315 6600 | 470 μμf, ±20%, 1000 V |
| C209 | 0315 2010 | 150 μμf, ±20% |
| C211 | 0315 2010 | 150 μμf, ±20% |
| C212 | 0312 2430 | 0.02 μf, +100 —0% |
| C213 | 0313 1040 | paper, 0.5 μf, ±20%, 200 V |
| C214 & C215 | 0312 2430 | 0.02 μf, +100 —0% |
| C216 | 0305 5540 | mica, 27 μμf, ±10% |
| C217 | 0316 2550 | paper, 0.25 μf, ±10%, 400 V |
| C218 & C219 | 0315 0530 | variable, 8-50 μμf, 350 V |
| C221 | 0315 0530 | variable, 8-50 μμf, 350 V |
| C222 | 0305 5620 | mica, 56 μμf, ±10% |
| C223 | 0315 0530 | variable, 8-50 μμf, 350 V |
| C224 | 0305 5540 | mica, 27 μμf, ±10% |
| C225 & C226 | 0315 6600 | 470 μμf, ±20%, 1000 V |
| C227 | 0315 2010 | 150 μμf, ±20% |
| C228 | 0313 1020 | paper, 0.1 μf, ±20%, 200 V |
| C229 | 0312 2430 | 0.02 μf, +100 —0% |
| C231 | 0313 1040 | paper, 0.5 μf, ±20%, 200 V |
| C232 | 0312 2430 | 0.02 μf, +100 —0% |
| C233 | 0313 1040 | paper, 0.5 μf, ±20%, 200 V |
| C301 | 0312 2430 | 0.02 μf, +100 —0% |
| C302 | 0301 9510 | paper, 0.04 μf, ±20%, 200 V |
| C304 | 0300 3070 | variable, 4-30 μμf |
| C305 | 0312 2430 | 0.02 μf, +100 —0% |
| C306 to C308 | 0313 1020 | paper, 0.01 μf, ±20%, 200 V |
| C309 | 0319 0071 | electrolytic, 50 μf, 300 V |
| C311 | 0312 2430 | 0.02 μf, +100 —0% |
| C312 | 0319 0071 | electrolytic, 50 μf, 300 V |

| Symbol | Part Number | Description |
|---|---|---|
| C313 | 0300 3070 | variable, 4-30 μμf |
| C314 | 0319 0071 | electrolytic, 50 μf, 300 V |
| C315 | 0313 1040 | paper, 0.5 μf, ±20%, 200 V |
| C316 | 0319 0061 | electrolytic, 100 μf, 150 V |
| C317 | 0317 6050 | electrolytic, 4 μf, 150 V |
| C318 | 0319 0061 | electrolytic, 100 μf, 150 V |
| C319 | 0312 2430 | 0.02 μf, +100 —0% |
| C401 | 0315 0530 | variable, 8-50 μμf, 350 V |
| C501 & C502 | 0317 5860 | electrolytic, 300 μf, 150 V |
| C503 | 0312 7620 | paper, 0.1 μf, ±20%, 400 V |
| C504 to C507 | 0301 4460 | electrolytic, 125 μf, +50 —10%, 350 V |
| C508 | 0312 7620 | paper, 0.1 μf, ±20%, 400 V |
| C509 | 0311 6350 | paper, 2 μf, ±5%, 600 V |
| C511 & C512 | 0301 4460 | electrolytic, 125 μf, +50 —10%, 350 V |
| C513 to C515 | 0312 2430 | 0.02 μf, +100 —0% |
| | **CIRCUIT BREAKER** | |
| CB501 | 0503 0060 | 1 pole, 6 amperes, 115 V ac |
| | **CRYSTALS** | |
| CR101 & CR102 | 2600 1530 | 1N34A |
| CR201 & CR202 | 2600 1530 | 1N34A |
| CR203 | 2600 5170 | 1N307 |
| CR204 | 2600 1530 | 1N34A |
| CR205 | 2600 5170 | 1N307 |
| | **RECTIFIERS** | |
| | (metallic) | |
| CR501 & CR502 | 2600 2080 | selenium, 400 ma |
| CR503 & CR504 | 2600 2110 | selenium, plug-in type, 600 ma |
| CR505 & CR506 | 2600 5000 | selenium, 50 ma |
| | **DISTRIBUTED LINE** | |
| DL301 | 8800 1451 | delay line |
| | **NEON REGULATOR** | |
| E501 | 1200 8931 | lamp, glow |
| | **LAMPS** | |
| I301 to I304 | 1200 0840 | incandescent, miniature bayonet, 0.250 ampere |
| I305 | 1200 0040 | neon indicator |
| I501 | 1200 1370 | incandescent, miniature bayonet, 0.250 ampere |
| | **RELAY** | |
| K301 | 0500 9740 | armature, DPDT |
| | **INDUCTORS** | |
| L201 | 2101 3080 | fixed, rf, ±10%, 220 μh |
| L301 & L302 | 2101 5481 | variable, 0.92-1.84 μh |

# section 5
# parts list and schematics

## RESISTORS

(all resistors are in ohms, fixed, composition, ±10%, ½ W unless otherwise specified)

| Symbol | Part Number | Description |
|---|---|---|
| R101 | 0225 2250 | 10M |
| R102 | 0225 2080 | 390K |
| R103 & R104 | 0225 1770 | 1K |
| R105 | 0225 2060 | 270K |
| R106 | 0225 2100 | 560K |
| R107 | 0225 4900 | 12K, 1 W |
| R108 | 0101 4850 | variable, 25K, ±20%, 2 W |
| R109 A, B | 0107 1271 | variable, 2.5M, ±20%, ¼ W |
| R111 & R112 | 0223 7290 | film, 200K, ±1% |
| R113 | 0225 1920 | 18K |
| R114 | 0225 4900 | 12K, 1 W |
| R115 | 0225 1920 | 18K |
| R116 | 0225 1950 | 33K |
| R117 | 0107 1023 | variable, 10K, ±20% |
| R118 | 0225 1930 | 22K |
| R119 | 0225 1870 | 6.8K |
| R120 | 0107 1039 | variable, 2.5M, ±25% |
| R121 | 0223 7650 | film, 2M, ±1% |
| R122 | 0230 4580 | wire wound, inductive, 5.6K, ±5%, 3 W |
| R123 | 0225 1810 | 2.2K |
| R124 | 0225 0230 | 91, ±5% |
| R125 & R126 | 0225 1730 | 470 |
| R127 | 0225 1890 | 10K |
| R201 A, B | 0107 0421 | variable, 100K/500K, ±20% |
| R202 | 0225 1870 | 6.8K |
| R203 | 0223 7230 | film, 120K, ±1% |
| R204 | 0230 4490 | wire wound, inductive, 1K, ±5%, 3 W |
| R205 | 0225 1960 | 39K |
| R206 | 0107 1024 | variable, 25K, ±20% |
| R207 | 0225 1650 | 100 |
| R208 | 0230 4510 | wire wound, inductive, 1.5K, ±5%, 3 W |
| R209 | 0225 1810 | 2.2K |
| R211 | 0225 1960 | 39K |
| R212 | 0107 1024 | variable, 25K, ±20% |
| R213 | 0225 1870 | 6.8K |
| R214 | 0105 6060 | variable, 50K, ±20%, ¼ W |
| R215 | 0223 7260 | film, 150K, ±1% |
| R216 | 0230 4490 | wire wound, inductive, 1K, ±5%, 3 W |
| R217 | 0225 1650 | 100 |
| R218 | 0230 4510 | wire wound, inductive, 1.5K, ±5%, 3 W |
| R219 | 0225 1810 | 2.2K |
| R220 | 0225 1700 | 270 |
| R221 | 0225 1720 | 390 |
| R222 | 0225 1530 | 10 |
| R223 | 0225 1570 | 22 |
| R224 | 0224 6510 | wire wound, 300, 15 W |
| R225 & R226 | 0203 6800 | 22K, ±5%, 2 W |
| R227 | 0225 0400 | 470, ±5% |
| R228 & R229 | 0224 6520 | wire wound, 1K, 15 W |
| R231 | 0203 7970 | 47K, 2 W |
| R232 A, B | 0107 1261 | variable, 10M, ±40%, ¼ W |
| R233 | 0225 2250 | 10M |
| R234 A, B, C | 0107 1241 | variable, 5M/2M/150K, ±30/20/10% |
| R235 | 0223 7290 | film, 200K, ±1% |
| R236 | 0223 7260 | film, 150K, ±1% |
| R237 | 0107 3900 | variable, 10M, ±40%, ¼ W |
| R241 | 0224 3950 | film, 130K, ±1% |
| R242 | 0107 3900 | variable, 10M, ±40%, ¼ W |
| R243 | 0107 1024 | variable, 25K, ±20% |
| R244 | 0225 1960 | 39K |
| R245 | 0225 1870 | 6.8K |
| R246 | 0225 1650 | 100 |
| R247 | 0230 4510 | wire wound, inductive, 1.5K, ±5%, 3 W |
| R248 | 0230 4490 | wire wound, inductive, 1K, ±5%, 3 W |
| R249 | 0225 1810 | 2.2K |
| R251 | 0225 1610 | 47 |
| R252 | 0225 1530 | 10 |
| R253 | 0230 4630 | wire wound, inductive, 10K, ±5%, 3 W |
| R254 | 0225 1770 | 1K |
| R255 | 0225 1570 | 22 |
| R256 | 0225 1790 | 1.5K |
| R257 & R258 | 0101 4840 | variable, 10K, ±20%, 2 W |
| R259 | 0225 1530 | 10 |
| R261 | 0107 1024 | variable, 25K, ±20% |
| R262 | 0225 2050 | 220K |
| R301 | 0225 1930 | 22K |
| R302 | 0107 1024 | variable, 25K, ±20% |
| R303 | 0225 1930 | 22K |
| R304 | 0230 4060 | film, 1080, ±2%, 13 W |
| R305 | 0225 1990 | 68K |
| R306 | 0225 2130 | 1M |
| R307 | 0225 2070 | 330K |
| R308 | 0225 1770 | 1K |
| R309 | 0105 6810 | variable, 2.5K, ±30%, ¼ W |
| R310 | 0225 2010 | 100K |
| R311 | 0225 2250 | 10M |
| R312 | 0225 4970 | 47K, 1 W |
| R313 & R314 | 0225 1530 | 10 |
| R315 | 0225 0310 | 200, ±5% |
| R316 | 0225 1530 | 10 |
| R317 | 0225 1770 | 1K |
| R318 | 0225 0310 | 200, ±5% |
| R319 | 0225 1530 | 10 |
| R320 | 0225 1770 | 1K |
| R321 | 0221 8040 | wire wound, 750, ±5%, 10 W |
| R322 | 0225 1770 | 1K |
| R323 | 0225 0310 | 200, ±5% |
| R324 | 0225 1530 | 10 |
| R325 | 0225 1770 | 1K |
| R326 & R327 | 0203 7550 | 15, 2 W |
| R328 & R329 | 0203 7530 | 10, 2 W |
| R331 & R332 | 0230 4050 | film, 150, ±2%, 13 W |
| R333 | 0210 0650 | wire wound, 1 |
| R334 & R335 | 0203 6210 | 75, ±5%, 2 W |
| R336 | 0203 7710 | 330, 2 W |
| R337 | 0225 1530 | 10 |
| R338 | 0225 0890 | 51K, ±5% |
| R339 | 0225 1000 | 150K, ±5% |
| R341 | 0225 1970 | 47K |
| R342 | 0225 1990 | 68K |
| R343 | 0105 6830 | variable, 100K, ±30%, ¼ W |
| R344 | 0225 1890 | 10K |
| R345 | 0225 2020 | 120K |
| R346 to R348 | 0225 1530 | 10 |
| R401 | 0224 3490 | film, 5.73, ±1% |
| R402 | 0224 3570 | film, 215.2, ±1% |
| R403 & R404 | 0224 3490 | film, 5.73, ±1% |
| R405 | 0224 3570 | film, 215.2, ±1% |
| R406 & R407 | 0224 3490 | film, 5.73, ±1% |
| R408 | 0224 3570 | film, 215.2, ±1% |
| R409 & R410 | 0224 3490 | film, 5.73, ±1% |
| R411 | 0224 3570 | film, 215.2, ±1% |
| R412 | 0224 3490 | film, 5.73, ±1% |
| R413 | 0224 3470 | film, 2.87, ±1% |
| R414 | 0224 3580 | film, 434, ±1% |
| R415 | 0224 3470 | film, 2.87, ±1% |
| R416 | 0224 3430 | film, 1.44, ±1% |
| R417 | 0224 3600 | film, 868.3, ±1% |
| R418 | 0224 3430 | film, 1.44, ±1% |
| R419 | 0224 3540 | film, 96.25, ±1% |

| Symbol | Part Number | Description |
|---|---|---|
| R420 | 0224 3500 | film, 71.25, ±1% |
| R421 | 0224 3540 | film, 96.25, ±1% |
| R422 | 0224 3500 | film, 71.25, ±1% |
| R423 & R424 | 0224 3540 | film, 96.25, ±1% |
| R425 | 0224 3500 | film, 71.25, ±1% |
| R426 & R427 | 0224 3540 | film, 96.25, ±1% |
| R428 | 0224 3500 | film, 71.25, ±1% |
| R429 & R430 | 0224 3540 | film, 96.25, ±1% |
| R431 | 0224 3550 | film, 142.5, ±1% |
| R432 | 0230 4140 | film, 96.25, ±1%, 4 W |
| R433 | 0224 3550 | film, 142.5, ±1% |
| R434 | 0230 4140 | film, 96.25, ±1%, 4 W |
| R501 | 0223 9360 | wire wound, 5K, 5 W |
| R502 | 0225 2130 | 1M |
| R503 & R504 | 0225 1730 | 470 |
| R505 | 0225 1300 | 2.7M, ±5% |
| R506 & R507 | 0225 1530 | 10 |
| R508 | 0225 1240 | 1.5M, ±5% |
| R509 | 0225 1190 | 910K, ±5% |
| R511 & R512 | 0225 1100 | 390K, ±5% |
| R513 | 0225 2010 | 100K |
| R514 | 0223 5530 | film, 270K, ±1% |
| R515 | 0105 6820 | variable, 25K, ±30%, ¼ W |
| R516 | 0224 3960 | film, 160K, ±1% |
| R517 | 0230 4320 | wire wound, inductive, 20, ±5%, 3 W |
| R518 | 0225 2090 | 470K |
| R519 | 0225 2010 | 100K |
| R521 | 0225 1300 | 2.7M, ±5% |
| R522 to R524 | 0203 6060 | 18, ±5%, 2 W |
| R525 | 0225 1240 | 1.5M, ±5% |
| R526 | 0225 1190 | 910K, ±5% |
| R527 & R528 | 0225 1100 | 390K, ±5% |
| R529 | 0225 2010 | 100K |
| R531 | 0223 7260 | film, 150K, ±1% |
| R532 | 0105 6820 | variable, 25K, ±30%, ¼ W |
| R533 | 0224 3960 | film, 160K, ±1% |
| R534 | 0225 1570 | 22 |
| R535 & R536 | 0230 4490 | wire wound, inductive, 1K, ±5%, 3 W |

## SWITCHES

(All rotary switches are phenolic and the angle of throw is 60° between positions unless otherwise specified)

| Symbol | Part Number | Description |
|---|---|---|
| S101 | 0500 6793 | push-push |
| S102 | 0501 1911 | rotary, 30°, 4 sections, 6 positions |
| S103 | 0501 1921 | rotary, 1 section, 3 positions |
| S201 | 0501 1971 | rotary, 2 sections, 3 positions |
| S301 | 0501 1921 | rotary, 1 section, 3 positions |
| S401 to S406 | 0500 6793 | push-push |
| S407 | 0501 1901 | rotary, 2 sections, 6 positions |
| S501 | 0500 1130 | toggle, SPST |

## TRANSFORMERS

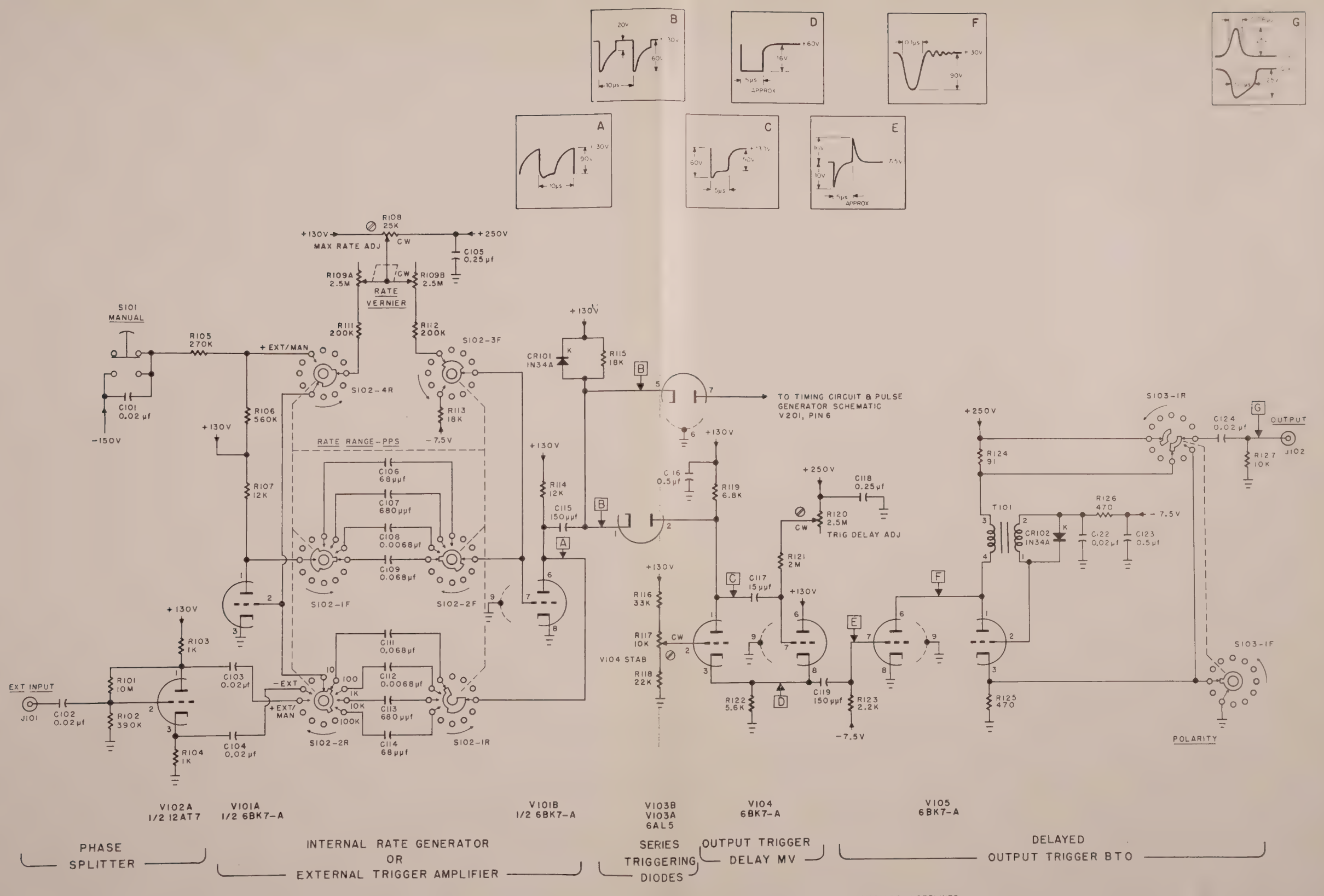
| | | |
|---|---|---|
| T101 | 2001 1080 | pulse |
| T201 | 2002 0000 | pulse |
| T202 | 2001 1080 | pulse |
| T203 & T204 | 2002 0000 | pulse |
| T501 | 2000 9982 | plate |
| T502 | 2000 9972 | filament |

## TUBES

| | | |
|---|---|---|
| V101 | 2500 8560 | 6BK7-A |
| V102 | 2500 1530 | 12AT7 |
| V103 | 2500 0020 | 6AL5 |
| V104 & V105 | 2500 8560 | 6BK7-A |
| V201 | 2501 1010 | 6463 |
| V202 | 2500 0050 | 6AU6 |
| V203 | 2501 1010 | 6463 |
| V204 | 2500 8560 | 6BK7-A |
| V205 & V206 | 2500 2950 | 5687 |
| V207 | 2501 1010 | 6463 |
| V208 | 2500 8560 | 6BK7-A |
| V209 & V210 | 2500 2950 | 5687 |
| V301 | 2500 7810 | 6BX7-GT |
| V302 & V303 | 2501 1190 | 6CB5-A |
| V304 to V306 | 2501 0250 | 6216 |
| V307 & V308 | 2500 0020 | 6AL5 |
| V309 & V310 | 2500 2950 | 5687 |
| V311 | 2501 1010 | 6463 |
| V312 | 2500 1530 | 12AT7 |
| V501 | 2501 0200 | 6AS7-GA |
| V502 & V503 | 2500 1500 | 12AX7 |
| V504 | 2500 9540 | CH1068 |
| V505 | 2500 1500 | 12AX7 |
| V506 | 2500 0300 | 0A2 |

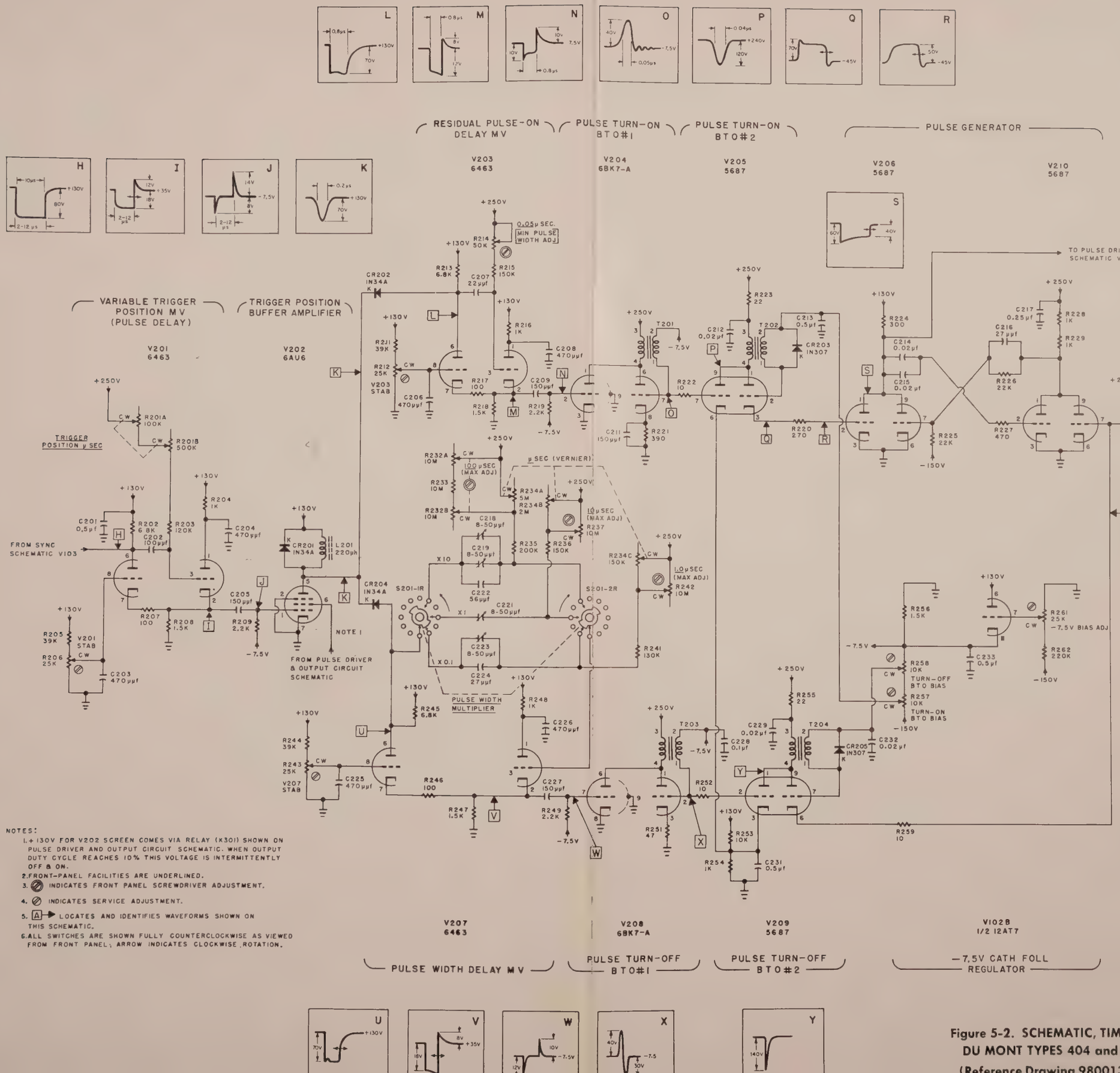
## CABLE

| | | |
|---|---|---|
| W501 | 5026 9541 | assembly, power, shielded, #18/2 AWG, 72 inches |




NOTES: 1. FRONT-PANEL FACILITIES ARE UNDERLINED.
2. ⊘ INDICATES SERVICE ADJUSTMENT.
3. ALL SWITCHES ARE SHOWN FULLY COUNTERCLOCKWISE AS VIEWED FROM FRONT PANEL; ARROW INDICATES CLOCKWISE ROTATION.
4. [A]→ LOCATES AND IDENTIFIES WAVEFORMS ON THIS SCHEMATIC.

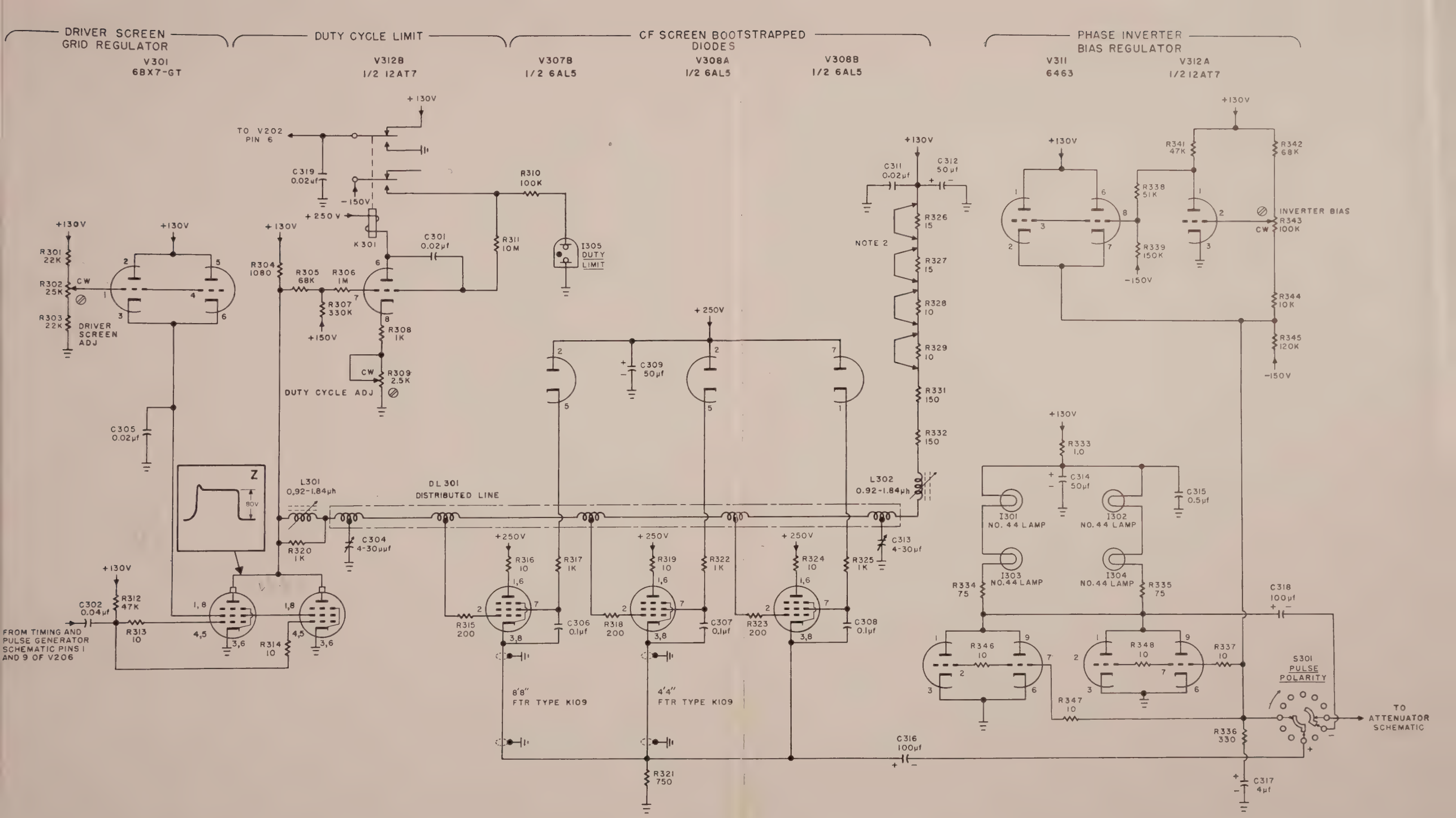
**Figure 5-1. SCHEMATIC, SYNCHRONIZER DU MONT TYPES 404 and 404-R PULSE GENERATORS**
**(Reference Drawing 98001381-4, Sheet 1 of 5, Issue 2)**




NOTES:

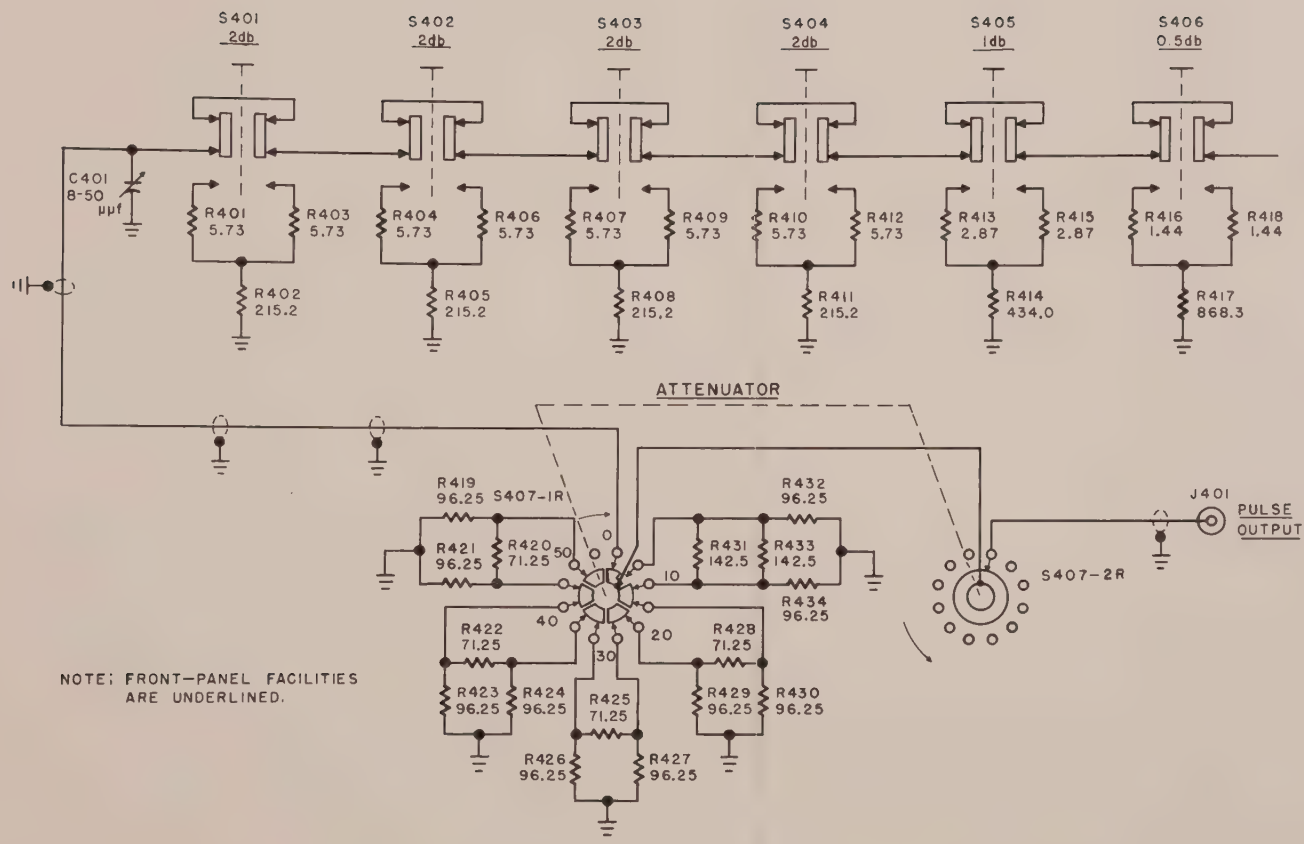
1. +130V FOR V202 SCREEN COMES VIA RELAY (K301) SHOWN ON PULSE DRIVER AND OUTPUT CIRCUIT SCHEMATIC. WHEN OUTPUT DUTY CYCLE REACHES 10% THIS VOLTAGE IS INTERMITTENTLY OFF & ON.
2. FRONT-PANEL FACILITIES ARE UNDERLINED.
3. ⊘ INDICATES FRONT PANEL SCREWDRIVER ADJUSTMENT.
4. ⊘ INDICATES SERVICE ADJUSTMENT.
5. [A]→ LOCATES AND IDENTIFIES WAVEFORMS SHOWN ON THIS SCHEMATIC.
6. ALL SWITCHES ARE SHOWN FULLY COUNTERCLOCKWISE AS VIEWED FROM FRONT PANEL; ARROW INDICATES CLOCKWISE ROTATION.

**Figure 5-2. SCHEMATIC, TIMING AND PULSE GENERATOR DU MONT TYPES 404 and 404-R PULSE GENERATORS**
**(Reference Drawing 98001381-4, Sheet 2 of 5, Issue 1)**




NOTES-1. ⊘ INDICATES SERVICE ADJUSTMENT
2. JUMPERS ACROSS R326 THROUGH R329 ARE ADDED OR OMITTED WHERE NECESSARY TO OBTAIN THE PROPER TERMINATION FOR DL 301
3 FRONT-PANEL FACILITIES ARE UNDERLINED

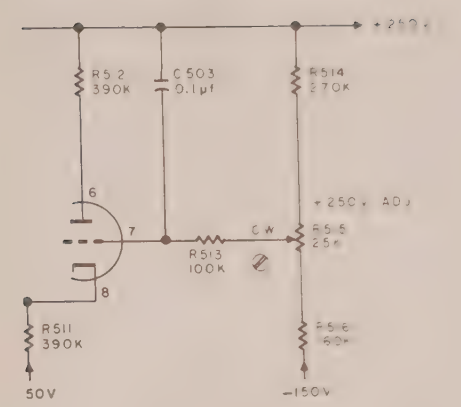
**Figure 5-3. SCHEMATIC, PULSE DRIVER AND OUTPUT DU MONT TYPES 404 and 404-R PULSE GENERATORS (Reference Drawing 98001381-4, Sheet 3 of 5, Issue 1)**

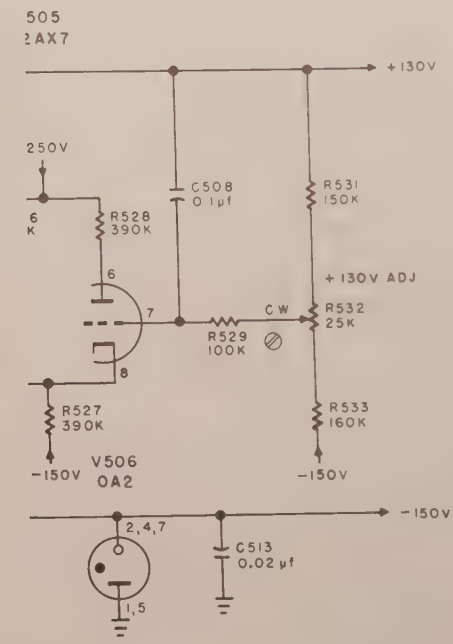



FROM PULSE DRIVER AND OUTPUT SCHEMATIC; S301 PULSE POLARITY.

NOTE: FRONT-PANEL FACILITIES ARE UNDERLINED.

Figure 5-4. SCHEMATIC, OUTPUT ATTENUATOR
DU MONT TYPES 404 and 404-R PULSE GENERATORS
(Reference Drawing 98001381-4, Sheet 4 of 5, Issue 1)



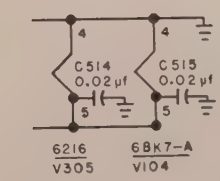
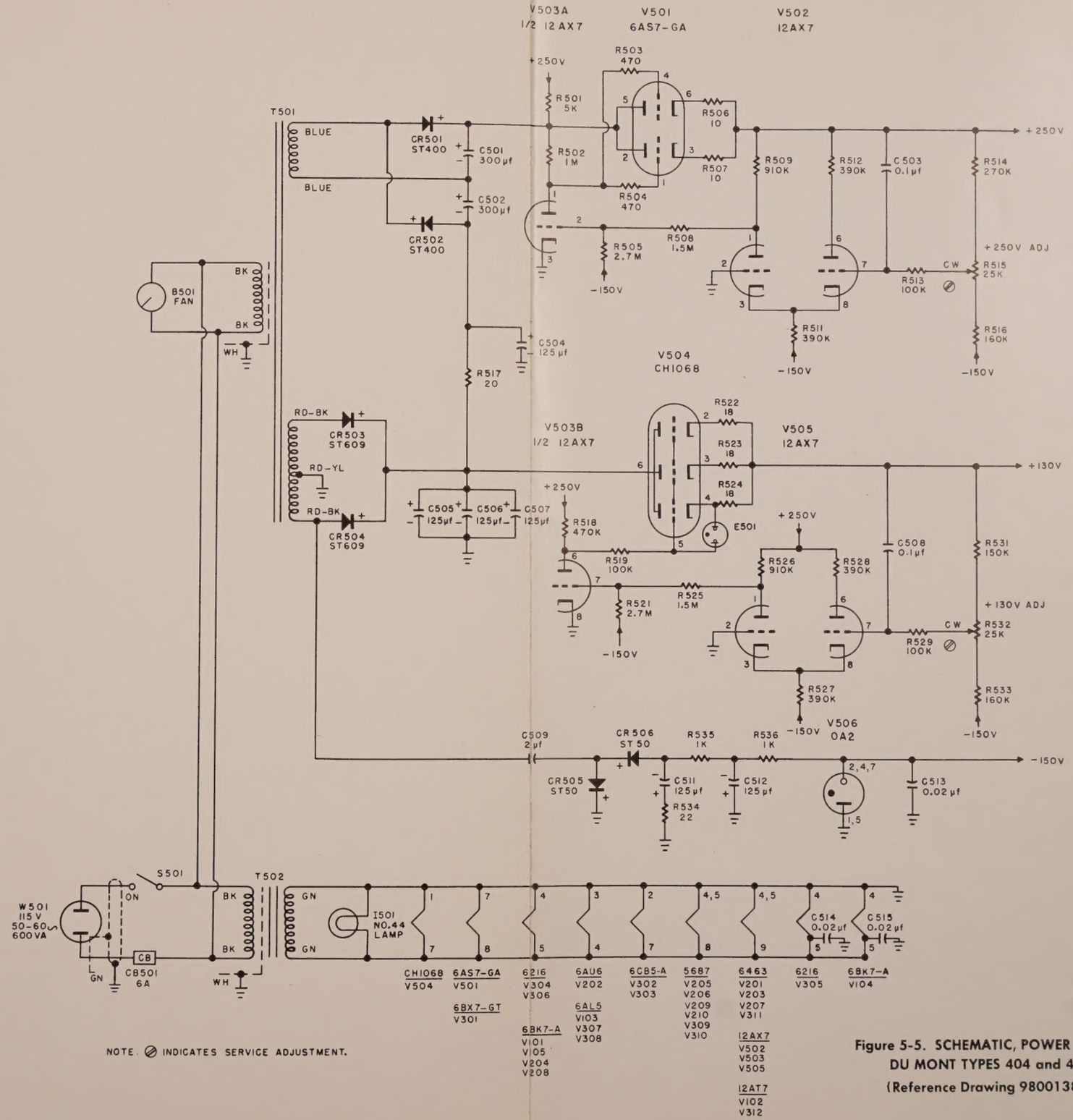




Figure 5-5. SCHEMATIC, POWER SUPPLY AND HEATER CIRCUITS
DU MONT TYPES 404 and 404-R PULSE GENERATORS
(Reference Drawing 98001381-4, Sheet 5 of 5, Issue 2)




NOTE. ⊘ INDICATES SERVICE ADJUSTMENT.

**Figure 5-5. SCHEMATIC, POWER SUPPLY AND HEATER CIRCUITS DU MONT TYPES 404 and 404-R PULSE GENERATORS**

**(Reference Drawing 98001381-4, Sheet 5 of 5, Issue 2)**

# WARRANTY AND SERVICE NOTICE
# for
# Industrial Type Cathode-ray Tubes and Instruments

### DU MONT INSTRUMENTS

Each instrument manufactured by the Technical Products Division of Allen B. Du Mont Laboratories, Inc., is guaranteed to equal or exceed its published performance specifications. It is further guaranteed against defective materials (other than the cathode-ray tube) and workmanship for a period of one year from delivery date. Any defective instrument or an instrument that does not meet or exceed our specifications will, upon inspection by us, be repaired or replaced at our discretion should such defect appear within the guarantee period.

To register this guarantee, the enclosed guarantee card must be properly filled out and mailed to the factory immefiately upon receipt of the equipment. Complete information is necessary. BOTH THE TYPE NUMBER AND THE SERIAL NUMBER OF THE INSTRUMENT MUST BE GIVEN ON THIS CARD.

Instruments must be examined immediately upon receipt, since claims for damage in transit will not be honored by the carrier unless prompt action is taken.

### DU MONT CATHODE-RAY TUBES

Industrial type cathode-ray tubes manufactured by Allen B. Du Mont Laboratories, Inc., are guaranteed for 1000 hours of operation or for a six-month period from date of shipment, whichever expires first. Adjustments will be made on the merit of each individual claim because of the widely varying applications to which such tubes are subjected, and a tube which becomes defective during the guarantee period will be replaced ONLY AFTER INSPECTION AT THE FACTORY. Cathode-ray tubes returned under the guarantee, must be shipped with transportation paid.

### BURNED-OUT HEATERS AND BROKEN GLASS ARE NOT COVERED BY THE TUBE GUARANTEE

To register a tube guarantee, the guarantee card enclosed with the tube must be filled out properly and mailed to the factory immediately upon receipt of the equipment. Complete information is necessary. TYPE NUMBER AND SERIAL NUMBER OF THE CATHODE-RAY TUBE MUST BE INCLUDED. The serial number of the tube will be found either on the glass stem of the electron-gun structure or on the bulb near the Du Mont brand. Tubes must be examined immediately upon receipt, since claims for damage in transit will not be honored by the carrier unless prompt action is taken.

### CHANGES IN SPECIFICATIONS

The right is reserved to change the published specifications of equipment at any time and to furnish merchandise in accordance with current specifications without incurring any liability to modify equipment previously sold, or to supply new equipment in accordance with earlier specifications excepting under the classification of special apparatus.

### SERVICE

In order to insure factory service under our guarantees, the guarantee cards enclosed with all instruments and tubes must be properly filled out and returned. In all cases where service or adjustment is requested, please write first to the factory giving complete information concerning the nature of the failure and describing the manner in which the equipment was used when failure occurred. THE TYPE NUMBER AND SERIAL NUMBER of the equipment must also be given. In this way, much time can be saved and unnecessary inconvenience often avoided. When writing in this respect, address:

**Allen B. Du Mont Laboratories, Inc.**
*Technical Products Division*
760 Bloomfield Avenue, Clifton, New Jersey

The Technical Products Division will then send to the customer, the written procedure for sending the instrument back to the factory. All equipment should be packed and shipped in accordance with this procedure; and identification tags should be attached to each tube or instrument.

### REPLACEMENT PARTS

If it is necessary to order a replacement component from the factory, always give the type number and serial number of the instrument and refer to the component by its symbol designation and description on the circuit schematic. This will help to expedite service.

DU MONT

Additional copies of this manual may be secured at a cost of two dollars each or twenty dollars per dozen copies; postpaid in the United States of America only.

www.manualsplus.com
1024881

**Allen B. DuMont Laboratories, Inc.**

**TECHNICAL PRODUCTS DIVISION**

**760 BLOOMFIELD AVENUE, CLIFTON, NEW JERSEY**